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THIRTY-SECOND ANNUAL REPORT

OF THE

STATE BOARD OF HEALTH

OF

MASSACHUSETTS.

BOSTON:
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1901.

MEMBERS OF THE BOARD.

1900–1901.

HENRY P. WALCOTT, M.D., *Chairman*,	of Cambridge.
JULIAN A. MEAD, M.D.,	of Watertown.
HIRAM F. MILLS, C.E.,	of Lawrence.
FRANK W. DRAPER, M.D.,	of Boston.
GERARD C. TOBEY, Esq.,	of Wareham.
JAMES W. HULL,	of Pittsfield.
CHARLES H. PORTER,	of Quincy.

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SAMUEL W. ABBOTT, M.D.

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X. H. GOODNOUGH, C.E.

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THEOBALD SMITH, M.D.

Analyst.

ALBERT E. LEACH.

Chemist.

H. W. CLARK.

Consulting Chemist.

THOMAS M. DROWN, M.D.

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GENERAL REPORT.

The following report comprises the general work of the State Board of Health for the year ended Sept. 30, 1900, together with its operations under the food and drug acts for the same period, and under the acts relating to water supply and sewerage during the calendar year 1900.

The first part, paged in Roman numerals, contained a condensed account of the work done under the laws defining the duties of the Board.

The regular work of the Board is performed mainly under the provisions of three separate acts, — an organic act of 1869, establishing the Board; an act of 1882, providing for the inspection of food and drugs; and an act for the protection of the purity of inland waters, of 1886, together with the amendments of these acts.

The second part of this report, paged in Arabic figures, presents the fuller details of the work of the Board under the acts above referred to.

The following members comprised the Board in 1900: —

HENRY P. WALCOTT, *Chairman.*

FRANK W. DRAPER.	GERARD C. TOBEY.
HIRAM F. MILLS.	CHARLES H. PORTER.
JAMES W. HULL.	JULIAN A. MEAD.

No changes have taken place in the membership of the Board in 1900.

GENERAL HEALTH OF THE STATE IN 1900.

As measured by the simple numerical standard of the death-rate, the health of the State in 1900 was not as satisfactory as that of the previous year, in which the death-rate fell to 17.4 per 1,000, being the lowest death-rate in the half-century just closed except those of the years 1859 and 1867, in which it was respectively 17 and 17.3 per 1,000 of the population.

The average death-rate of the half-century was 19.5 per 1,000. That of 1900 was 18.24.

Since it is possible to speak with greater precision of the mortality of 1900, on account of the taking of the national census in that year, the following figures are presented, for the ten years ended with 1900: —

Massachusetts.

Years.	Population.	Deaths.	Death-rates.	Years.	Population.	Deaths.	Death-rates.
1891,	2,288,911	45,185	19.74	1896,	2,558,443	49,381	19.30
1892,	2,339,993	48,762	20.84	1897,	2,618,051	47,419	18.11
1893,	2,392,216	49,084	20.52	1898,	2,679,049	46,761	17.46
1894,	2,445,604	46,791	19.14	1899,	2,741,470	47,710	17.40
1895,	2,500,183	47,540	19.01	1900,	2,805,346	51,156	18.24

The total number of registered deaths in 1900 was greater than that of any year in the period of registration.

In order that these figures may be compared with those of other countries, the following table is presented for the twenty-five years 1874–98, and for the year 1899: —

Countries.	Death-rate. 1874-98.	Death-rate. 1899.	Countries.	Death-rate. 1874-98.	Death-rate. 1899.
England and Wales,	19.4	18.3	Hungary,	33.2	27.0
Scotland,	19.7	18.6	German Empire,	24.6	21.5
Ireland,	18.1	17.6	France,	22.0	21.1
Norway,	16.7	16.8	Italy,	27.1	22.1
Sweden,	17.2	17.6	Massachusetts,	19.4	17.4
Austria,	29.0	25.4			

New England States, 1893-97.

Maine,	16.3*	Rhode Island,	18.7*
New Hampshire,	18.0*	Connecticut,	17.6*
Vermont,	16.8*	New England,	18.3*

Infectious Diseases.

The healthfulness of a particular district or city, or of any selected period of time, may be determined, not so much by the general death-rate as given above, but by the death-rate from the principal

* These figures for the New England States are for the five years 1893–97. The death-rate of Massachusetts for the same period of five years was 19.2 per 1,000.

infectious diseases. Sanitary measures have a decided effect in diminishing this class of diseases and in keeping their death-rate at a minimum; but there are other and unexplained causes which are constantly in operation in all countries and at all periods of time, which tend to produce fluctuations in the death-rate from the different infectious diseases.

These fluctuations are usually widespread, and when a marked change in the death-rate occurs in one State, it is usually found to follow the same course in the neighboring States.

The following brief table presents the deaths from each of the principal infectious diseases in Massachusetts in the two years 1899 and 1900: —

Deaths from Certain Infectious Diseases in 1899 and 1900.

Diseases.	1899.	1900.	Increase.	Decrease.
Small-pox,	14	3	-	11
Diphtheria and croup,	1,047	1,475	428	-
Scarlet fever,	235	391	156	-
Typhoid fever,	612	632	20	-
Measles,	241	330	89	-
Cholera infantum,	1,964	2,393	429	-
Consumption,	5,221	5,199	-	22
Dysentery,	268	257	-	11
Whooping-cough,	338	337	-	1
Pneumonia,	4,993	5,282	289	-
Cerebro-spinal meningitis,	240	198	-	42
Total,	15,173	16,497	1,411	87

Difference or net increase, 1,324.

This increase of 1,324 deaths from the principal infectious diseases over the number of the preceding year amounts to 8.7 per cent., whereas the ordinary increase of population would have indicated an increase of only 2.5 per cent., had the rate for the two years been uniform.

It is not alone in the foregoing statistics of deaths that an increased prevalence of infectious diseases is shown in the State for the year 1900, but also in the official returns received from cities and towns showing the actual number of cases reported as having occurred during the year.

As illustrating this fact, the following figures are selected from the pages of such published reports of local boards of health as were accessible for the years 1899 and 1900. They comprise the reported cases (not deaths) from diphtheria and scarlet fever which were reported to the local boards of health in 26 of the principal cities of the State in 1899 and 1900, including the 8 largest cities of the State: —

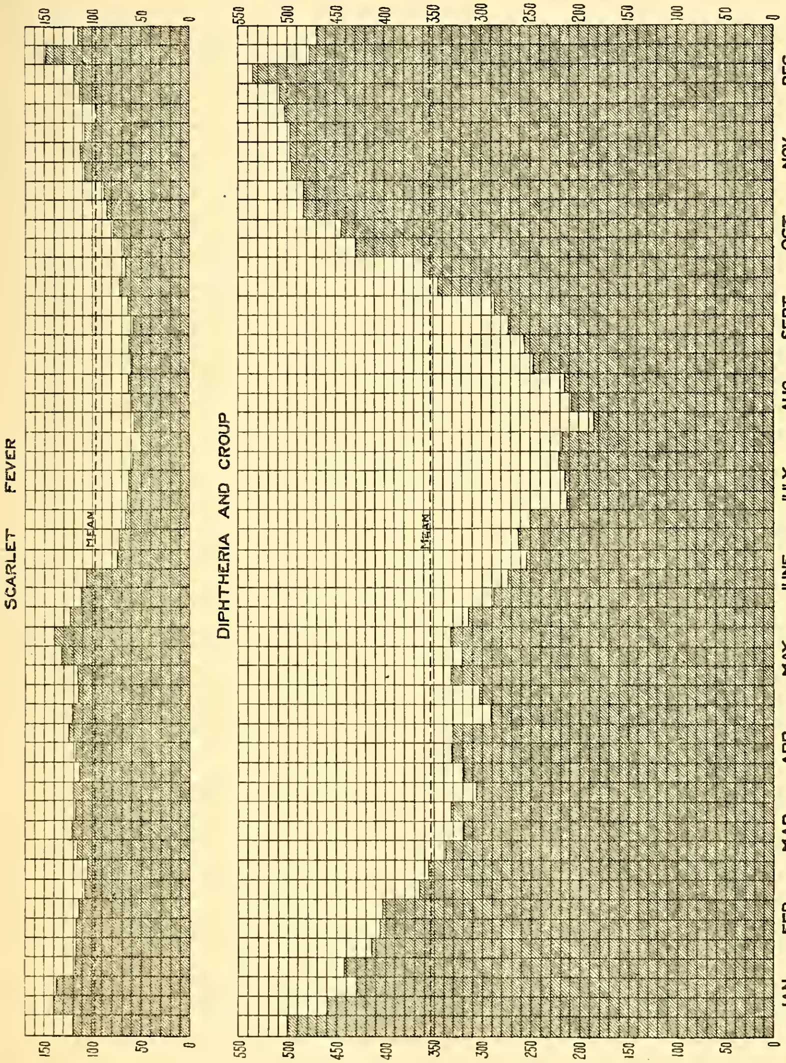
Cases of Diphtheria and Scarlet Fever reported to Local Boards of Health in 1899 and 1900 in Certain Cities.

Cities.	Diphtheria.		Scarlet Fever.	
	1899.	1900.	1899.	1900.
Beverly,	22	20	21	37
Boston,	2,836	4,977	1,381	1,710
Brockton,	53	135	31	25
Cambridge,	502	925	158	176
Chelsea,	86	248	27	44
Everett,	130	237	60	63
Fall River,	67	71	101	86
Fitchburg,	50	104	96	97
Haverhill,	101	83	82	123
Holyoke,	68	313	44	214
Lowell,	152	157	173	80
Lynn,	176	491	108	122
Malden,	56	140	67	164
Marlborough,	13	22	50	18
Medford,	47	90	65	209
New Bedford,	87	25	210	363
Newton,	183	361	59	117
Northampton,	30	33	30	102
Pittsfield,	21	42	88	116
Quincy,	77	224	59	39
Salem,	32	182	53	90
Somerville,	147	520	157	231
Springfield,	463	299	76	131
Waltham,	58	435	144	50
Woburn,	21	147	51	44
Worcester,	377	580	585	475
Total,	5,855	10,861	3,976	4,926

In the majority of these cities it appears that there was an increase in the prevalence of each disease, as shown by the figures. The increase in the sum of the reported cases of diphtheria in all these cities amounted to 85.5 per cent., and that of scarlet fever to 23.8 per cent.

This subject of the fluctuations in the prevalence of these two diseases has an important bearing upon school hygiene, or at least upon that branch of it which pertains to the prevention of the spread of disease among school children. Each of these two diseases shows a marked increase in its prevalence at about the time of the opening of the schools in September. Whether this is a mere coincidence, it is impossible to state, but the opinion of many observers seems to

strengthen the belief in this hypothesis. The accompanying diagram is the result of eighteen years' observations upon this point in Massachusetts, and is made up from the weekly returns of mor-



Reported Mortality from Diphtheria and Croup and from Scarlet Fever in Massachusetts, by weeks, for 18 years. (1883 – 1900)

tality made to the State Board from the principal cities and towns in the State; the sum of all the deaths from diphtheria in these years embraced in these returns was 18,332; and those from scarlet fever were 5,102.

Mortality from Diphtheria and Scarlet Fever by Weeks in Massachusetts in Eighteen Years, 1883-1900.

Week.	Diphtheria.	Scarlet Fever.	Week.	Diphtheria.	Scarlet Fever.	Week.	Diphtheria.	Scarlet Fever.
First,	501	120	Nineteenth,	332	115	Thirty-sixth,	257	62
Second,	459	140	Twentieth,	320	132	Thirty-seventh,	272	57
Third,	430	137	Twenty-first,	332	140	Thirty-eighth,	287	63
Fourth,	442	118	Twenty-second,	314	123	Thirty-ninth,	345	72
Fifth,	414	117	Twenty-third,	288	111	Fortieth,	360	66
Sixth,	406	117	Twenty-fourth,	273	106	Forty-first,	429	68
Seventh,	403	113	Twenty-fifth,	254	74	Forty-second,	444	78
Eighth,	365	107	Twenty-sixth,	262	72	Forty-third,	483	84
Ninth,	356	104	Twenty-seventh,	250	66	Forty-fourth,	483	87
Tenth,	338	116	Twenty-eighth,	212	64	Forty-fifth,	496	108
Eleventh,	319	121	Twenty-ninth,	215	62	Forty-sixth,	496	111
Twelfth,	332	118	Thirtieth,	221	58	Forty-seventh,	497	107
Thirteenth,	306	120	Thirty-first,	218	50	Forty-eighth,	503	95
Fourteenth,	319	113	Thirty-second,	185	57	Forty-ninth,	508	113
Fifteenth,	331	117	Thirty-third,	208	59	Fiftieth,	535	120
Sixteenth,	330	124	Thirty-fourth,	215	62	Fifty-first,	477	149
Seventeenth,	291	121	Thirty-fifth,	247	59	Fifty-second,	469	114
Eighteenth,	303	114						

Total reported deaths from diphtheria in the eighteen years,	18,332
Total reported deaths from scarlet fever in the eighteen years,	5,102
Mean weekly mortality from diphtheria for eighteen years,	19.6
Mean weekly mortality from scarlet fever for eighteen years,	5.4

It is worthy of notice that the increase of diphtheria from August to November is more rapid and sharply defined than that of scarlet fever, and reaches its maximum usually in November, continuing at about the same rate through December and January, but beginning to fall in February.

These diseases have pursued this course with considerable uniformity in Massachusetts throughout most of this period.

Consumption.

The statistics of this disease, so far as can be gathered from the returns of deaths, are extremely encouraging, since they present an almost uniform decrease from a maximum of 42.7 deaths per 1,000 of the population in 1853 to a minimum of only 18.5 in 1900, or considerably less than half as great as at the middle of the century.

Not only has the death-rate from this destructive disease sensibly diminished, but the absolute number of deaths has also fallen from a maximum of 5,955 in 1885 to a minimum of 5,199 in 1900; and for the first time in the history of the registration of the State has the number of deaths from this disease taken the second place in the list, instead of the first, the deaths from pneumonia exceeding those from consumption in 1900 by 83.

The following table presents the death-rate from consumption in Massachusetts for the first ten years and the last ten years of the past half-century: —

Death-rates from Consumption in Massachusetts per 10,000 Inhabitants.

Years.	Ten Years, 1851-60. Death-rates from Consumption.	Years.	Ten Years, 1891-1900. Death-rates from Consumption.
1851,	39.0	1891,	24.0
1852,	39.7	1892,	24.5
1853,	42.7	1893,	23.1
1854,	41.8	1894,	22.3
1855,	41.9	1895,	21.9
1856,	40.8	1896,	21.7
1857,	39.5	1897,	20.8
1858,	38.4	1898,	19.7
1859,	38.9	1899,	19.0
1860,	37.0	1900,	18.5

Small-pox.

Small-pox prevailed in Massachusetts in 1900 to about the same extent as in the previous year, the reported cases of undoubted character in 1899 having been 105 and those in 1900 being 104.

Place. — These occurred in 14 cities and towns, as follows: in Fall River, 37 cases; in Lowell, 23; in Westport, 19; in Boston, 6; in Chicopee, 5; in Middleborough, 3; in Malden, 2; in Oxford, 2; in Acushnet, 2; and in Lawrence, Worcester, Taunton, Gardner and Watertown, 1 each. No cases were reported from paper-mill cities and towns.

Conditions as to Vaccination. — Of the whole number attacked 18 had been vaccinated, 84 were unvaccinated and the facts in regard to 2 were not stated.

Season. — By months the cases were distributed as follows: —

January,	3	July,	15
February,	2	August,	6
March,	1	September,	1
April,	3	October,	5
May,	17	November,	3
June,	47	December,	1

As in the previous year, the greater number of cases occurred in summer; 89 cases, or 85 per cent., were reported between April 1 and October 1. This is contrary to the average experience of a long series of years. Observations extending over forty years (1850–95) show that the period of greatest prevalence is usually in winter.

Sex. — Of the whole number attacked 55 were males, 48 were females, and the sex of 1 was not stated. Of the whole number attacked with small-pox in the State since and including 1885 wherein the sex was stated 297 were males and 255 were females.

Ages. — The ages of those who were attacked were as follows: under 1 year, 7; 1 to 5 years, 24; 5 to 10 years, 18; 10 to 15 years, 3; 15 to 20 years, 15; 20 to 30 years, 26; 30 to 40 years, 5; 40 to 50 years, 5; 50 to 60 years, 1.

The following table contains the statistics by ages of the cases and deaths from small-pox in the vaccinated and the unvaccinated, and among those in which the facts as to vaccination were unknown or doubtful. These relate to those cases and deaths which occurred in the 13 years 1888–1900.

Fatality of the Vaccinated and Unvaccinated in Massachusetts (1888–1900). Thirteen Years. By Ages.

Ages.	Vaccinated.		Unvaccinated.		Doubtful.		Total.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
0 to 1 year,	1	-	30	11	1	-	32	11
1 to 5 years,	9	-	71	8	1	-	81	8
5 to 10 years,	6	-	35	2	5	-	46	2
10 to 15 years,	19	-	10	-	2	-	31	-
15 to 20 years,	24	1	39	6	6	2	69	9
20 to 30 years,	85	5	68	12	16	4	169	21
30 to 40 years,	35	5	20	6	3	1	58	12
40 to 50 years,	27	3	5	3	4	-	36	6
Over 50 years,	18	2	-	-	3	1	21	3
Unknown,	3	-	1	-	4	-	8	-
	227	16	279	48	45	8	551	72

This table contains very valuable information relative to the protective power of vaccination at different age periods. Only 1 vaccinated infant under one year of age was attacked with small-pox, and

this child survived, while there were 30 attacks of unvaccinated infants under one year of age, and of these 11 died, or 36.7 per cent. Among vaccinated persons under fifteen years of age there were 35 attacks, and *no deaths*. Among unvaccinated persons under fifteen years old there were 146 attacks and 21 deaths, or 14.4 per cent. Among vaccinated adults over fifteen years of age there were 189 attacks and 16 deaths, or 8.5 per cent. Among unvaccinated adults over fifteen years old there were 132 attacks and 27 deaths, or 20.4 per cent.

It is also worthy of note that 70 school children or children of school ages (five to fifteen years) were attacked during these thirteen years, and of this number 45, or about two-thirds, were unvaccinated. Out of this whole number (70) there were only 2 deaths, this being the age period in which the specific intensity of life is greatest, *i.e.*, the power to resist fatal attacks of illness.

Out of the 227 who were recorded as having been vaccinated it was stated in the returns that 124, or nearly 55 per cent., had been vaccinated in infancy only, and judging from the carefully recorded statistics of other countries, it is safe to presume that the 16 deaths of vaccinated adults occurred among this class exclusively.

Nationality. — Of the whole number attacked in 1900 77, or three-fourths, were French Canadians, all of whom except 7 were unvaccinated; 11 were natives of the United States, 6 of Ireland, 6 of Poland, and 1 each from four other countries.

It is also worthy of comment that the circumstances in many cases showed a serious disregard of the laws relating to vaccination, since 20 school children between the ages of five and fifteen years who were attacked in 1900 were unvaccinated, in violation of the provisions of chapter 496 of the Acts of 1898, section 11, and 18 out of 21 mill operatives were also unvaccinated, in violation of chapter 515 of the Acts of 1894.

In addition to the cases enumerated in the foregoing summary, mention should be made of an epidemic which occurred at New Bedford, during which 174 persons were attacked with a disease resembling small-pox, but of a milder character. Out of this number there were no deaths, and the diagnosis was doubtful.

The first cases were observed and reported in the latter part of June, from which time the epidemic increased, and was at its height in August and September.

The local board of health in its annual report makes the following statement with reference to this epidemic: —

After careful consideration of the nature of this epidemic, which existed both in this city and in other sections of the State, the board concludes that it had to deal with a mild form of genuine small-pox. This conclusion is strengthened by the fact that 22 of the patients at the small-pox hospital were vaccinated by us after being discharged as cured, and in no instance was the vaccination successful.

The cases were reported to the State Board of Health as cases of a contagious eruptive disease.

The following table presents the detailed account of the cases reported to the Board in 1900: —

Record of Cases of Small-pox reported to the State Board of Health during the Year 1900, under the Provisions of Chapter 138 of the Acts of 1883.

Number.	Date of Report.	Place of Occurrence.	Nationality of Patient.	Occupation.	Age.	Sex.	Previously Vaccinated.	Number of Scars.	Number of Deaths.
1	Jan. 12,	Boston, . .	West Indies, .	Sailor, . . .	23 years.	M.	No.	-	-
2	Jan. 15,	Malden, .	United States,	- -	4 years.	M.	No.	-	-
3[1]	Jan. 26,	Malden, .	United States,	Soap factory, .	27 years.	F.	Yes.	-	-
4[2]	Feb. 2,	Boston, . .	United States,	Engineer, . .	26 years.	M.	Yes.	1	-
5[2]	Feb. 1,	Lawrence, .	United States,	Drug clerk, . .	25 years.	M.	Yes.	2	-
6	Mar. 24,	Boston, . .	United States,	R.R. porter, . .	23 years.	M.	No.	-	-
7	April 20,	Fall River, .	French Canadian.	Laborer, . .	24 years.	M.	No.	-	-
8[2]	April 23,	Worcester, .	Ireland, . .	- -	23 years.	F.	Yes.	1	-
9[2]	April 27,	Boston, . .	Norway, . .	Domestic, . .	47 years.	F.	Yes.	-	-
10[2]	May 12,	Boston, . .	United States,	Iron moulder, .	37 years.	M.	Yes.	1	-
11[2]	May 16,	Boston, . .	Ireland, . .	- -	22 years.	F.	Yes.	1	-
12[3]	May 3,	Chicopee, .	Poland, . .	- -	7 years.	M.	No.	-	1
13[3]	May 17,	Chicopee, .	Poland, . .	- -	3 years.	F.	No.	-	-
14[3]	May 14,	Chicopee, .	Poland, . .	- -	2½ years	M.	No.	-	-
15[3]	May 16,	Chicopee, .	Poland, . .	- -	5 years.	F.	No.	-	-
16[3]	May 16,	Chicopee, .	Poland, . .	- -	7 years.	F.	No.	-	-
17[3,4]	May 21,	Lowell, . .	French Canadian.	- -	7 years.	F.	-	-	-
18[3]	May 24,	Lowell, . .	French Canadian.	- -	6 years.	F.	-	-	-
19[3]	May 29,	Lowell, . .	French Canadian.	Cotton mill operative.	24 years.	F.	No.	-	-
20[3]	May 29,	Lowell, . .	French Canadian.	- -	1 year.	F.	No.	-	-

[1] Vaccinated too late to be protective. [2] Vaccinated in infancy. [3] Patients worked in cotton mills.
[4] Reported to have been vaccinated a year ago, but there are no scars.

Record of Cases of Small-pox reported to the State Board of Health during the Year 1900, under the Provisions of Chapter 138 of the Acts of 1883 — Continued.

Number.	Date of Report.	Place of Occurrence.	Nationality of Patient.	Occupation.	Age.	Sex.	Previously Vaccinated.	Number of Scars.	Number of Deaths.
21	May 10,	Fall River, .	French Canadian.	Laborer, . .	22 years.	M.	No.	-	-
22	May 10,	Fall River, .	French Canadian.	- -	2 years.	F.	No.	-	-
23	May 10,	Fall River, .	French Canadisu.	- -	14 mos.	F.	No.	-	1
24	May 10,	Fall River, .	French Canadian.	- -	4 years.	F.	No.	-	-
25	May 23,	Fall River, .	United States,	Shoemaker, . .	16 years.	M.	No.	-	-
26	May 23,	Fall River, .	French Canadian.	- -	6 years.	F.	No.	1	-
27	June 1,	Lowell, . .	French Canadian.	Cotton mill operative.	16 years.	F.	No.	-	-
28	June 5,	Westport, .	French Canadian.	Cotton mill operative.	23 years.	F.	No.	-	-
29	June 5,	Westport, .	French Canadian.	Cotton mill operative.	18 years.	M.	No.	-	-
30	June 5,	Westport, .	French Canadian.	Farmer, . . .	26 years.	M.	No.	-	-
31	June 8,	Westport, .	French Canadian.	- -	9 years.	M.	No.	-	-
32	June 8,	Westport, .	French Canadian.	Mill operative, .	16 years.	M.	No.	-	-
33	June 8,	Westport, .	French Canadian.	- -	11 years.	M.	No.	-	-
34	June 8,	Westport, .	French Canadian.	- -	17 years.	F.	No.	-	-
35	June 8,	Westport, .	French Canadian.	- -	9 years.	F.	No.	-	-
36[1]	June 8,	Lowell, . .	French Canadian.	Mill operative, .	28 years.	M.	Yes.	-	-
37	June 10,	Lowell, . .	French Canadian.	Janitor, . . .	41 years.	M.	No.	-	-
38[1]	June 10,	Lowell, . .	French Canadian.	Housewife, . .	40 years.	F.	Yes.	-	-
39	June 12,	Lowell, . .	French Canadian.	Machine shop, .	27 years.	M.	No.	-	-
40	June 12,	Westport, .	French Canadian.	- -	6 years.	F.	No.	-	-
41	June 12,	Westport, .	French Canadian.	Mill operative, .	19 years.	F.	No.	-	-
42	June 12,	Westport, .	French Canadian.	- -	4 years.	M.	No.	-	-
43[2]	June 18,	Lowell, . .	French Canadian.	Laborer, . .	30 years.	M.	Yes.	1	-
44	June 13,	Westport, .	French Canadian.	Mill operative, .	19 years.	M.	No.	-	-
45	June 21,	Westport, .	French Canadian.	Mill operative, .	20 years.	F.	No.	-	-
46	June 22,	Fall River, .	French Canadian.	- -	1 year.	M.	No.	-	-
47	June 13,	Fall River, .	French Canadian.	- -	10 years.	M.	No.	-	-
48	June 18,	Fall River, .	French Canadian.	- -	3 years.	F.	No.	-	-
49	June 2,	Fall River, .	French Canadian.	- -	7 years.	M.	No.	-	-
50	June 4,	Fall River, .	French Canadian.	Housewife, . .	22 years.	F.	No.	-	-
51	June 4,	Fall River, .	French Canadian.	Laborer, . .	43 years.	M.	No.	-	-
52	June 4,	Fall River, .	French Canadian.	- -	32 years.	F.	No.	-	-
53	June 5,	Fall River, .	French Canadian.	Mill operative, .	16 years.	F.	No.	-	-
54	June 5,	Fall River, .	French Canadian.	- -	12 years.	M.	No.	-	-

[1] Vaccinated in infancy. [2] Vaccinated eight years ago.

Record of Cases of Small-pox reported to the State Board of Health during the Year 1900, under the Provisions of Chapter 138 of the Acts of 1883 — Continued.

Number.	Date of Report.	Place of Occurrence	Nationality of Patient.	Occupation.	Age.	Sex.	Previously Vaccinated.	Number of Scars.	Number of Deaths.
55	June 5,	Fall River, .	French Canadian	Mill operative, .	15 years.	M.	No.	-	-
56	June 5,	Fall River, .	French Canadian.	Weaver, . .	19 years.	M.	No.	-	-
57	June 6,	Fall River, .	French Canadian.	Mill operative, .	19 years.	M.	No.	-	-
58	June 7,	Fall River, .	French Canadian.	Weaver, . .	18 years.	M.	No.	-	-
59[1]	June 10,	Fall River, .	French Canadian.	Fireman, . .	36 years.	M.	Yes.	3	-
60	June 10,	Fall River, .	French Canadian.	- -	9 mos.	M.	No.	-	-
61	June 11,	Fall River, .	French Canadian.	- -	9 years.	M.	No.	-	-
62	June 11,	Fall River, .	French Canadian.	- -	3 years.	M.	No.	-	-
63[2]	June 14,	Middleborough.	Ireland, . .	Laborer, . .	39 years.	M.	Yes.	1	-
64	June 15,	Middleborough	Ireland, . .	- -	7 years.	M.	No.	-	-
65	June 15,	Middleborough.	Ireland, . .	- -	9 years.	M.	No.	-	-
66	June 23,	Fall River, .	French Canadian.	- -	1 year.	F.	No.	-	-
67	June 23,	Fall River, .	French Canadian.	- -	5 years.	M.	No.	-	-
68	June 23,	Fall River, .	French Canadian.	- -	4 years.	F.	No.	-	-
69	June 23,	Fall River, .	French Canadian.	Mill operative, .	22 years.	M.	No.	-	-
70	June 25,	Fall River, .	French Canadian.	Weaver, . .	25 years.	M.	No.	-	-
71	June 25,	Fall River, .	French Canadian.	- -	6 years.	F.	No.	-	-
72[3]	June 30,	Westport, .	French Canadian.	Housekeeper, .	60 years.	F.	Yes.	-	-
73	June 29,	Fall River, .	French Canadian.	- -	8 years.	F.	No.	-	-
74	July 10,	Lowell, . .	Ireland, . .	Weaver, . .	44 years.	F.	Yes.	-	-
75[4]	July 10,	Westport, .	French Canadian.	Mill operative, .	28 years.	F.	Yes.	1	-
76	July 6,	Westport, .	French Canadian.	- -	2 years.	F.	No.	-	-
77	July 14,	Lowell, . .	French Canadian.	Laborer, . .	30 years.	M.	No.	-	-
78	July 9,	Fall River, .	French Canadian.	- -	3 years.	F.	No.	-	-
79	July 27,	Fall River, .	French Canadian.	- -	7 mos.	M.	No.	-	-
80	July 17,	Fall River, .	French Canadian.	- -	25 years.	F.	No.	-	-
81	July 17,	Fall River, .	French Canadian.	- -	2 years.	F.	No.	-	-
82	July 25,	Lowell, . .	French Canadian.	- -	4 years.	M.	No.	-	-
83	July 25,	Lowell, . .	French Canadian.	- -	6 years.	M.	No.	-	1
84	July 25,	Lowell, . .	French Canadian.	- -	3 years.	F.	No.	-	-
85	July 26,	Lowell, . .	French Canadian.	- -	1 year.	-	No.	-	-
86	July 27,	Lowell, . .	United States,	- -	4 years.	F.	No.	-	-
87	July 28,	Lowell, . .	United States,	- -	6 years.	M.	No.	-	-

[1] Vaccinated twenty-three years ago.
[2] Vaccinated in infancy.
[3] Vaccinated fifty years ago.
[4] Vaccinated four years ago.

Record of Cases of Small-pox reported to the State Board of Health during the Year 1900, under the Provisions of Chapter 138 of the Acts of 1883 — Concluded.

Number.	Date of Report.	Place of Occurrence.	Nationality of Patient.	Occupation.	Age.	Sex.	Previously Vaccinated.	Number of Scars.	Number of Deaths.
88	July 28,	Lowell, . .	United States,	- -	2 years.	F.	No.	-	-
89	Aug. 1,	Lowell, . .	French Canadian.	- -	4 years.	M.	No.	-	-
90	Aug. 1,	Lowell, . .	French Canadian.	- -	2 years.	M.	No.	-	-
91	Aug. 3,	Fall River, .	French Canadian.	Mill operative, .	25 years.	M.	No.	-	-
92	Aug. 12,	Lowell, . .	French Canadian.	- -	8 years.	M.	No.	-	-
93	Aug. 12,	Lowell, . .	French Canadian.	Mill operative, .	18 years.	M.	No.	-	-
94	Oct. 16,	Fall River, .	Poland.	- -	1½ years.	M.	No.	-	-
95	Oct. 21,	Westport, .	French Canadian.	- -	3 years.	M.	No.	-	-
96	Oct. 28,	Westport, .	French Canadian.	- -	1½ years.	F.	No.	-	-
97	Oct. 29,	Taunton, .	French Canadian.	Mill operative, .	26 years.	F.	No.	-	-
98	Oct. 30,	Westport, .	French Canadian.	- -	4 years.	F.	No.	-	-
99[1]	Nov. 14,	Oxford, . .	French Canadian.	Housewife, . .	42 years.	F.	Yes.	1	-
100	Nov. 14,	Oxford, . .	French Canadian.	Domestic, . .	27 years.	F.	No.	-	-
101	Nov. 17,	Gardner, .	French Canadian.	Chairmaker, . .	25 years.	M.	No.	-	-
102	Aug. 27,	Acushnet, .	- -	Milkman, . .	17 years.	M.	No.	-	-
103	Sept. 5,	Acushnet, .	United States,	School girl, . .	16 years.	F.	Yes.	3	-
104[2]	Dec. 29,	Watertown, .	British Provinces.	Domestic, . .	24 years.	F.	Yes.	1	-

[1] Vaccinated thirty years ago. [2] Vaccinated fifteen years ago.

The type of the epidemic of small-pox which visited Massachusetts during the past year (1900) was not only much milder than that of the preceding year, but, so far as existing records show, it was milder than any previous epidemic of the disease in this State. The number of cases reported in 1900 was almost exactly the same as that of the preceding year, yet the fatality was less than one-quarter as great, the deaths in 1900 being only 3 in number, as compared with 14 in the previous year. This unusually mild type of disease was observed in many other parts of the Union where small-pox was prevalent, especially in Pennsylvania, Ohio, Illinois, Missouri and Kansas.

The following graphic picture refers to the appearance of the disease as seen in Kansas in 1899 by a physician who, with his colleagues, had seen about 200 cases of this character.

The two to four days (usually three) of fever are uniformly present. Most of the patients complain of some aching in the head, back and limbs. A few complain of severe aching. When the rash appears there is uniformly a decline in the temperature and a feeling of relief. When the vesicles are not opened and pus forms there is a slight increase of fever from about the seventh to the tenth day. If the vesicles are opened and washed with some antiseptic lotion, little or no increase is noted. In none of the cases is there any deep or extended inflammation around the spots. They seem to be mostly in the epidermis or just below it, not in the derma. In a few cases there is umbilication, in about one to seven or twenty spots. Most of the spots are rounded throughout. The centre of the spots holds the liquid, and by pricking it, all the fluid can be easily squeezed out. When the scab is formed no pus is found under it if it is pulled off. The rash takes from two to five days to come out. It appears on the soft palate, one in eight to fifteen cases. The rash appears less frequently in the axilla and the groin.*

The same writer draws the following reasonable conclusions relative to the prevention of the disease: —

The conclusions which one is justified in drawing from the facts here set forth are as old as the days of Jenner and as imperative as in the year when the clear-sighted von Hebra wrote his chapters on small-pox so lucidly and emphatically that to-day they present a true picture, as well of the virus as of its most efficient antidote. Vaccination and revaccination of everybody, — child, adult, foreigner, native-born, — there is no other safe reliance for the present and the future. By the methods known and found most effective in the care of the public health the epidemic must be stamped out and the disease at last completely eradicated.

This mild type of small-pox prevailed in Massachusetts a year later than that of the western and middle States.

In consequence of the continued prevalence of small-pox and the neglect of vaccination, especially among certain classes of immigrants from other countries, the following circular was issued by the Board during the year: —

Vaccination.

[A Circular from the State Board of Health. — June, 1900]

Last year the Board issued a general circular on the subject of small-pox and vaccination, but the continued occurrence of outbreaks of small-pox, mostly among communities insufficiently protected by vaccination, makes it

* Dr. Jas. Nevins Hyde, in an open letter entitled "Touching the Symptoms and Diagnosis of the Epidemic of Modified Small-pox prevalent in Some Portions of the United States." Published by the Illinois State Board of Health.

necessary to urge again upon all local sanitary authorities the importance of vaccination as the best of all the means for combating this disease and preventing its further spread. Of these different means, — notification, isolation, vaccination and disinfection, — the protection afforded by vaccination appears to have been neglected most of all. These different weapons for preventing the spread of this disease should all be employed and not one of them should be neglected.

Recent investigations by the Board show that a very considerable portion of the population of the State is still without the protection afforded by vaccination; this condition of insecurity is partly due to the improper performance of the operation, but is mostly in consequence of its entire neglect.

Vaccination gives a protection which is more complete than can be obtained by any other means, and even when this protection is not absolute, it has been thoroughly demonstrated that vaccination renders the individual much less liable to an attack of small-pox, and if the attack does occur, the severity of the disease is greatly modified.

Most of the objections urged against vaccination are the result either of the employment of bad methods of operation or of improper material. The operation is a surgical one, and is liable to the same accidents to which any simple, minor surgical operation is exposed, no more and no less, hence similar precautions are necessary in each instance.

The objections once urged against the use of humanized lymph are now obviated by the almost universal use of lymph obtained from the calf.

The Board recommends the use of glycerinated lymph as likely to produce the most uniformly favorable results.

In view, therefore, of the possible appearance of small-pox, it is earnestly recommended that a general vaccination of all unprotected persons be made, and that the local authorities of cities and towns be requested to carry out this recommendation.

When examination of the pupils in the public schools is made with reference to vaccination, this work should be done before the usual summer closing of the schools, and such examination should be made by a competent physician.

Method of Vaccination.

In order to insure the best possible results in vaccinating, the following instructions should be observed: —

1. The use of glycerinated calf lymph from reputable sources is recommended. If this cannot be procured, ivory points well coated and of recent date may be used. Crusts, either humanized or from the heifer, should never be employed.

2. Except so far as any immediate danger from small-pox may require, vaccinate only subjects who are in good health. So far as infants are concerned ascertain that there is no febrile condition, nor irritation of the bowels, nor an unhealthy state of the skin. Do not, except of necessity, vaccinate where there has been recent exposure to the infection of measles or scarlet fever, nor where erysipelas exists in the household.

3. The sleeve of the left arm should be rolled up to the shoulder and secured,

The arm should then be cleansed with a mild antiseptic (such as a five per cent. solution of boracic acid) and rubbed dry with a clean towel or napkin. Active disinfectants should not be employed.

4. At least three places, not less than three-fourths inch apart, should then be scarified with a sterilized lancet or needle, each scarified area being not over one-fourth inch in diameter. The lymph should then be thoroughly rubbed into each of these scarifications.

5. Allow the scarified surfaces to dry thoroughly before the sleeve is replaced. Direct that care be taken to keep the vesicles uninjured during their progress, and that the resulting crusts should not be prematurely removed. If the habits or clothing of the vaccinated person do not appear to be strictly clean, use a shield made of stiffened fabric, the outer edge of which has been made adhesive, or, if necessary, secure it over the scarified area by means of adhesive strips.

6. Instruct each vaccinated person to return at the end of a week for inspection.

7. Keep a record of each vaccination. For this purpose the Board recommends the employment of a register containing the following items: —

1	2	3	4	5		6	7	8	9	10	11		12	13		
				Age.							Result.			Certificate of School Vaccination Given.		
Consecutive Number of Cases.	Date of Vaccination.	Name of Vaccinated Person.	In Case of Revaccination at Ages over Ten Years, of Persons Previously Successfully Vaccinated, Mark R.	Years.	Months.	Residence.	Source of Lymph. Name of Producer.	Number of Separate Scarified Areas or Punctures Made.	Initials of Vaccinator.	Date of Inspection.	Successful Number of Separate Vesicles Produced.	Unsuccessful	Initials of Inspector.	Yes.	No.	Remarks.
1																
2																
3																
4																
5																

Copies of the foregoing blank form, or blank books containing one hundred or two hundred copies of the same, will be forwarded to any local board of health upon application.

The left-hand page of this register (columns 1 to 9) is to be filled for each individual case on the day of vaccination. The opposite page (columns 10 to 13) on the day of inspection at a later period.

When a vaccination or revaccination has to be repeated on account of want of success in the first operation, it should be entered as a fresh case in the register.

If the operation is not performed by a physician, the occupation of the vaccinator should be stated in column 9.

In cases of primary vaccination, record as "successful" those cases only in which the normal vesicle has been produced. In cases of revaccination, record as "successful" only those in which the vesicles, normal or modified, or papules surrounded with areolæ, have resulted.

8. Keep all instruments used in vaccination in perfect aseptic condition, and use them for no other purpose.

When vaccinating have sterilized water and a clean napkin at hand, and invariably cleanse your vaccinating instrument after each operation, before proceeding to another.

When points or tubes have once been charged with lymph and have been put to

their proper use, break or otherwise destroy them, so that they may not be used a second time, either for the conveyance or storage of lymph.

9. Certificates of vaccination to be used for admitting pupils to schools should not be granted until after the vaccinated pupil has been inspected and the vaccination has been found to be successful.

10. The following is proposed as a form of certificate of successful vaccination: —

____

(Name of City or Town.)

______________________________*19*_____

Date.

*I hereby certify that*___________________________________*has been successfully vaccinated.*

____*M.D.*

Typhoid Fever.

The death-rate from typhoid fever in any large city or community of people may be considered an index of the purity of the public water supply. There are, however, many limitations of this statement, or sources of error, which it becomes necessary to take into account, as, for example, the use of other supplies by a considerable portion of the population, such as the use of the polluted waters of the canals in several of our manufacturing cities for drinking purposes. Again, the common practice of visiting picnic and camp grounds and summer resorts outside the city limits, where the water supply is often of doubtful quality.

In the report of 1896, page 781, a table and diagram were presented indicating the relation between the mortality from typhoid fever and the progress made in the introduction of pure water into cities and towns.

The improvement in the death-rate from this disease appears to have been continuous, with a fairly uniform rate of decrease during the past twenty years or more. In the following table the death-rates from typhoid fever are presented for each of the 33 cities of the State by five-year periods for the past thirty years. By this method the irregularities due to small numbers and short periods of time are eliminated.

The total number of deaths from typhoid fever embraced in this table is 16,298, and the death-rate of these cities had diminished from 8.2 per 10,000 in the period 1871–85 to 2.6 in 1896–1900, that of the last period being less than one-third as great as that of the first period.

In further proof of this very decided improvement the mean

typhoid death-rate of those cities in either of the first four periods 1871–90 was much greater even than the highest typhoid death-rate of any city in the last period. This improvement has been effected, not only by the introduction of new water supplies, but also by the purification of those which already existed.

Deaths and Death-rates per 10,000 Inhabitants from Typhoid Fever in Massachusetts Cities, 1871–1900.

Cities.	1871-1875. Deaths from Typhoid Fever.	1871-1875. Death-rate from Typhoid Fever per 10,000.	Cities.	1876-1880. Deaths from Typhoid Fever.	1876-1880. Death-rate from Typhoid Fever per 10,000.	Cities.	1881-1885. Deaths from Typhoid Fever.	1881-1885. Death-rate from Typhoid Fever per 10,000.
Holyoke,	157	23.3	Holyoke,	77	8.1	Holyoke,	159	12.8
Springfield,	214	14.8	Lawrence,	122	6.6	Chicopee,	48	8.4
Chicopee,	63	12.6	Chicopee,	35	6.5	Lowell,	243	7.9
Lawrence,	190	11.9	Fall River,	152	6.4	North Adams,	43	7.6
Lowell,	221	9.8	Malden,	31	5.4	Lawrence,	144	7.4
Fall River,	176	9.8	Springfield,	86	5.3	Fall River,	174	6.6
Pittsfield,	56	9.6	Worcester,	131	4.9	Sprlngfield,	117	6.6
Brockton,	43	9.2	Haverhill,	40	4.8	Taunton,	59	5.3
Chelsea,	86	8.7	Salem,	61	4.6	Lynn,	109	5.2
Northampton,	46	8.7	Newburyport,	31	4.6	Haverhill,	52	5.2
New Bedford,	99	8.4	Pittsfield,	29	4.5	Boston,	952	5.1
Worcester,	176	7.8	Lowell,	117	4.3	Pittsfield,	34	4.9
Lynn,	118	7.8	Quincy,	21	4.3	Brockton,	41	4.8
Boston,	1,145	7.7	Marlborough,	20	4.3	Quincy,	27	4.8
Somerville,	69	7.6	North Adams,*	16	4.3	Salem,	66	4.7
Salem,	87	6.9	Lynn,	72	4.1	Northampton,	29	4.6
Taunton,	65	6.7	Boston,	690	3.9	New Bedford,	62	4.1
Haverhill,	46	6.6	New Bedford,	50	3.8	Marlborough,	20	3.8
Marlborough,	27	6.4	Gloucester,	34	3.8	Cambridge,	103	3.7
Gloucester,	51	6.3	Chelsea,	36	3.4	Gloucester,	38	3.7
Cambridge,	124	5.7	Medford,	12	3.4	Everett,	9	3.6
Woburn,	26	5.7	Taunton,	34	3.3	Newton,	31	3.4
Malden,	25	5.5	Northampton,	19	3.3	Worcester,	106	3.3
Fitchburg,	32	5.4	Beverly,	13	3.3	Somerville,	45	3.3
Beverly,	18	5.2	Newton,	25	3.0	Newburyport,	22	3.2
Quincy,	19	4.6	Somerville,	33	2.8	Chelsea,	37	3.1
Newburyport,	29	4.5	Fitchburg,	17	2.8	Malden,	21	3.0
Everett,	6	4.1	Brockton,	14	2.3	Waltham,	20	3.0
Medford,	11	3.6	Cambridge,	55	2.2	Fitchburg,	18	2.6
Newton,	20	2.8	Woburn,	10	2.0	Medford,	11	2.6
Waltham,	13	2.7	Waltham,	8	1.5	Woburn,	14	2.5
			Everett,	2	1.0	Beverly,	10	2.3
Total,	3,458	–	....	2,093	–	....	2,864	–
Means for the cities,	–	8.2	....	–	4.2	....	–	5.1
The State,	–	8.2	....	–	4.5	....	–	5.0

* North Adams not incorporated till 1878.

Deaths and Death-rates per 10,000 Inhabitants from Typhoid Fever in Massachusetts Cities, 1871-1900 — Concluded.

CITIES.	1886-1890. Deaths from Typhoid Fever.	1886-1890. Death-rate from Typhoid Fever per 10,000.	CITIES.	1891-1895. Deaths from Typhoid Fever.	1891-1895. Death rate from Typhoid Fever per 10,000.	CITIES.	1896-1900. Deaths from Typhoid Fever.	1896-1900. Death-rate from Typhoid Fever per 10,000.
Lowell, . . .	396	11.2	North Adams, .	74	8.4	North Adams, .	42	3.9
Lawrence, . .	233	11.2	Lawrence, . .	187	7·7	Newburyport, .	27	3.7
North Adams, .	64	8.9	Lowell, . .	294	7.3	New Bedford, .	98	3.3
Chicopee, . .	43	6.7	Chicopee, . .	50	6.6	Chicopee, . .	28	3.1
Fall River, . .	209	6.4	Woburn, . .	33	4.8	Boston, . .	822	3.1
Holyoke, . .	105	6.6	Newburyport, .	29	4.1	Beverly, . .	19	3.0
Marlborough, .	32	5.2	Springfield, .	97	4.1	Quincy, . .	34	3.0
Quincy, . .	37	5.1	Quincy, . .	37	4.0	Haverhill, . .	52	2.9
Pittsfield, . .	40	5.0	Salem, . . .	63	3.9	Northampton, .	26	2.9
Haverhill, . .	59	4.8	Fall River, . .	154	3.8	Lynn, . . .	88	2.7
Taunton, . .	58	4.7	Holyoke, . .	72	3.8	Springfield, .	76	2.7
Springfield, . .	88	4.3	Haverhill, . .	49	3.4	Somerville, . .	73	2.6
Salem, . . .	59	4.0	Marlborough, .	24	3.3	Taunton, . .	38	2.6
Newton, . .	44	4.0	New Bedford, .	77	3.2	Lowell, . .	113	2.5
Boston, . . .	818	3.9	Boston, . .	722	3.1	Everett, . .	27	2.5
New Bedford, .	71	3.8	Somerville, . .	65	2.8	Pittsfield, . .	25	2.5
Brockton, . .	46	3.8	Brockton, . .	41	2.7	Brockton, . .	46	2.5
Woburn, . .	24	3.8	Malden, . .	36	2.7	Fall River, . .	114	2.4
Cambridge, . .	116	3.6	Medford, . .	17	2.7	Lawrence, . .	68	2.4
Malden, . .	33	3.3	Worcester, . .	120	2.6	Waltham, . .	25	2.3
Fitchburg, . .	31	3.3	Cambridge, .	91	2.4	Cambridge, .	94	2.2
Everett, . .	14	3.3	Chelsea, . .	35	2.4	Melrose, . .	14	2.2
Northampton, .	22	3.2	Everett, . .	18	2.4	Chelsea, . .	35	2.1
Worcester, . .	109	2.8	Lynn, . . .	64	2.2	Salem, . .	37	2.1
Somerville, . .	49	2.8	Taunton, . .	29	2.2	Holyoke, . .	44	2.0
Chelsea, . .	35	2.6	Newton, . .	28	2.2	Newton, . .	31	2.0
Newburyport, .	17	2.5	Northampton, .	17	2.1	Fitchburg, . .	27	1.9
Lynn, . . .	56	2.2	Beverly, . .	11	1.9	Medford, . .	15	1.8
Gloucester, . .	25	2.2	Fitchburg, . .	22	1.8	Malden, . .	28	1.8
Medford, . .	11	2.2	Waltham, . .	18	1.8	Worcester, . .	95	1.7
Waltham, . .	17	2.0	Gloucester, . .	18	1.3	Gloucester, . .	22	1.6
Beverly, . .	10	2.0	Pittsfield, . .	25	1.3	Woburn, . .	9	1.3
						Marlborough, .	3	0.4
Total, . . .	2,971	-	....	2,617	-	....	2,295	-
Means for the cities,	-	4.6	....	-	3.4	....	-	2.6
THE STATE, . .	-	4.1	....	-	3.2	....	-	2.4

* Melrose incorporated 1898.

Malaria.

Within the past decade considerable progress has been made with reference to the causation of malarial fever. It appears to be set-

tled that certain conditions are essential to its introduction into an inhabited district where it has hitherto been absent, and these are (1) the coming into the district of persons suffering with attacks of malarial fever; (2) the existence of certain species of mosquitoes; (3) the existence of bodies of stagnant water of greater or less size in which these insects are accustomed to breed.

There is no evidence to show that malarial fever is communicable from one human being directly to another, as is the case with some infectious diseases.

If, therefore, either or all of these conditions are interfered with, the progress of the disease may be prevented. The coming of large bodies of laborers from malarious countries into new districts in this State, for the purpose of introducing water works, systems of sewers, railroads or other public works, has been coincident with extensive epidemics of malarial fever, which were often attributed to the upturning of new soil, but which were probably due to the presence of the men who turned up the soil.

With reference to the existence of mosquitoes, very much may be done in the way of prevention. A knowledge of their habits shows that they breed in stagnant water, no matter how shallow or small in amount. Hence their destruction may be effected in these bodies of water, the most effective method being the use of petroleum or of kerosene oil, which, being poured upon the surface, will destroy the larvæ of mosquitoes in the water. All open cisterns, barrels or other receptacles of water should be covered so that mosquitoes may not gain access to them, especially when they are near inhabited houses. To prevent the access of mosquitoes to the interior of inhabited houses, all open doors and windows in malarial districts should be provided with tight-fitting screens throughout the warm seasons of the year, and people living in such districts should be instructed to remain indoors after sunset.

The perfect insect may also be destroyed in rooms by the burning of a small quantity of pyrethrum (insect powder) sufficient to make a dense smoke in the apartment.

With reference to the treatment of stagnant bodies of water, much improvement can be effected not only by the treatment with crude petroleum, or kerosene oil as stated before, but also by the thorough drainage of moist lands, or by filling with earth where drainage cannot be effected. By such means as these, malaria has

already been very greatly diminished in some Italian towns where it had once been a serious menace to life and health. Similar work in Cuba has also been followed by a marked diminution in the prevalence of yellow fever.

Another important item in the line of prevention is the treatment of all persons who are suffering with this disease. In every case medical aid should be sought and treatment given at once.

The Alleged Increase of Cancer.

In the last report of the Board (page xl) it was stated that an investigation was in progress having "reference to the causes and conditions prevailing throughout the State in connection with the existence of cancer among the population."

The statistical portion of this inquiry was entrusted to Dr. W. F. Whitney, whose conclusions are given in the present report.

The conclusions only which Dr. Whitney has formed as the results of his researches are stated in this report, the main portion of the text of his paper having been already published in the Transactions of the Medical Society for 1901 as the Shattuck lecture, before that society.

The substance of his conclusions is contained in the third section, to the effect that the increase of cancer is apparent, rather than real, and is "probably due to the better diagnosis and registration, and until the ratio of deaths over thirty years to the total mortality at the same ages has reached eight or nine per cent., which is shown by autopsies to be the true rate for cancer, it is not justifiable to speak of the increase of cancer as inherent in the disease itself."

Food and Drug Inspection.

Primarily, the object of a system of food and drug inspection is the protection of the community from injurious or harmful adulterations, and it was chiefly with this object in view that a system of inspection was devised, a law was enacted providing for its execution, and the work of inspection was entrusted to the State Board of Health. The first general inspection which was made, however, showed that the majority of adulterations which were practised were of a fraudulent and not of a harmful character. As a matter of economy and convenience, however, both kinds of inspection and analysis can readily be carried out in the laboratory and under one set of

officials, whether it be analysis of milk and butter, or that of other kinds of food for the presence of arsenic, lead and other poisons.

The usefulness of this line of work is fully demonstrated year by year, not only by the large amount of routine work which is annually accomplished in the inspection of food and drugs, and the prevention of adulteration by such measures as are within the power of the Board, but also by the great amount of new work which is annually made necessary by the appearance of new forms of adulteration and fraud.

Very much good is accomplished by the correspondence with parties outside the State, which constantly tends to the improvement of the articles furnished for consumption in this State, and the securing of conformity with the standards adopted in Massachusetts.

This correspondence has very largely increased during the years which have elapsed since the enactment of the law in 1897, requiring the name and percentage of each ingredient to be attached to every package of food sold or offered for sale as a compound or mixture.

Arsenic in Manufactures and Food.

Several different Legislatures have considered the question of limiting the amount of arsenic in manufactured goods, such as wall papers, wearing apparel and other fabrics, but no efficient law was enacted in this State until 1900, when upon the recommendation of the committee of public health of the Legislature a law was enacted prescribing definite limits of the amount of arsenic allowable in such articles. The State Board of Health was charged with the duty of "making investigations and adopting such measures as it might deem necessary to carry out the provisions and facilitate the enforcement of the act."

Previous to the enactment of this law, a law was passed in 1891 (chapter 374) prohibiting the manufacture and sale of toys and confectionery containing arsenic. This law was of little service, since the use of arsenic in coloring toys had ceased and no confectionery was found to contain this poison. But the sale of wall papers and of other fabrics containing arsenic still continued, and occasional instances were reported of injury to persons from exposure to this poison as existing in such manufactured products.

As a result of this prolonged investigation (the first paper published by the Board on this subject being that of Dr. Draper in the

third report of the Board, 1872) the definite law of 1900 was enacted. Very soon after the passage of this act the following circular was published by the Board and sent throughout the State to persons who are specially affected by its provisions: —

Arsenic in Manufactures.

The Massachusetts Legislature of 1900 enacted a law relating to the manufacture and sale of articles containing arsenic, and directed the State Board of Health to make the necessary investigations relative to the existence of arsenic in the materials mentioned in the act, and to adopt such measures as may be deemed necessary to carry out its provisions and to facilitate its enforcement.

The act is as follows: —

[Chapter 325, Acts of 1900.]

An Act relative to the manufacture and sale of textile fabrics and papers containing arsenic.

Section 1. Any corporation, person, firm or agent who directly or by an agent manufactures, sells, exchanges, or has in his custody or possession with intent to sell or exchange, any woven fabric or paper containing arsenic in any form, or any article of dress or of household use composed wholly or in part of such woven fabric or paper, shall on conviction thereof be punished by fine of not less than fifty nor more than two hundred dollars: *provided, however*, that this section shall not apply to dress goods or articles of dress containing not more than one one-hundredth grain, or to other materials or articles containing not more than one-tenth grain of arsenic per square yard of the material.

Section 2. The state board of health shall make all necessary investigations as to the existence of arsenic in the materials and articles mentioned in section one of this act, may employ inspectors and chemists for that purpose, and shall adopt such measures as it may deem necessary to carry out the provisions and to facilitate the enforcement of this act.

Section 3. This act shall take effect on the first day of January in the year nineteen hundred and one. [*Approved May 18, 1900.*

Inasmuch as it will become the duty of the State Board of Health, after Jan. 1, 1901, to enforce the provisions of the foregoing act, this circular is published and distributed by the Board for the information and guidance of such corporations, persons, firms or agents as are mentioned in the act.

By Order of the State Board of Health.

Soon after the enactment of the law in question a collection was made of such articles as were mentioned in the act, and these were submitted to the chemist of the Board, Mr. A. E. Leach, for analysis. His report upon the subject presents the results of analysis of 157

samples of paper and woven fabrics. Of this number, 34 contained arsenic, but only 7 samples contained quantities beyond the legal limit. In one sample the amount was excessive (41¼ grains per square yard).

Out of 186 samples of dress goods 81 contained arsenic, and of these, 27 had amounts beyond the legal limit. In 2 samples the amount contained was more than 1 grain per square yard, but in no instance did it exceed 2 grains per square yard in any of the samples of this class which were submitted to the analysis.

The law herewith quoted prescribes a certain definite limit of the amount of arsenic allowable in wall papers and fabrics; but it makes no provision relative to the presence of arsenic in articles of food or drugs. This is provided for in the general statute of 1882, wherein any article of food is deemed to be adulterated "if it contains any added poisonous ingredient."

In the case of drugs it is also provided that an article shall be deemed to be adulterated if "it differs from the standard of strength, quality or purity laid down" in the United States Pharmacopœia. Similar provisions are made for drugs not named in the United States Pharmacopœia.

It has been argued by manufacturers and wholesalers that a limit of arsenic might properly be allowed in articles of food and in drugs, but recent experiences have shown that such limits are not desirable, and that for all drugs not containing arsenic as an officinal constituent, and especially for all articles of food, absolute freedom from this dangerous poison should be required.

This position is strengthened by the recent occurrences which have taken place in England during the past year. By the report of Dr. Buchanan to the Local Government Board of England, dated Jan. 7, 1901, it appears that 3,652 persons in Manchester and other neighboring places in England suffered from arsenic poisoning in consequence of having partaken of beer which contained arsenic. The arsenic was introduced into the beer as an impurity of the glucose used in the process of manufacture. Many deaths were determined to have resulted from this species of poisoning.

Further investigations relative to the presence of arsenic in certain drugs and other articles of food will be reported upon in the next annual report.

Manual of Health Laws.

In 1882 a manual was published containing the laws of the State relating to the public health, together with such decisions of the supreme court as had been made relating to them up to that date.

From that time to 1900 it has been the custom of the Board, at intervals of three or four years, to publish a new edition, containing all the statutes relating to health up to the date of publication.

The book has been found useful, especially to local boards of health, since, without its aid, it might frequently become necessary to search not only the Public Statutes published in 1882, but also nineteen large annual volumes of statutes published in the intervening years between the date and the present year, in order to find any sanitary statutes which had been enacted during the period which has elapsed since 1882.

During the past two years a commission has been engaged in revising the statutes, with the purpose of publishing the existing laws in one volume similar to that of 1882, and now this work is nearly completed. If a new manual of health laws were to be published now, it would be entirely out of date in a few months in consequence of this revision, which must necessarily change the numbering of statutes and sections. It has, therefore, been deemed prudent to wait until the new revision is complete before a new manual is published.

Offensive Trades.

Under the provisions of the statutes relating to the regulation of offensive trades, authority is given, both to the State and to local boards of health for their supervision. No petitions have been presented to the State Board during the past year for action in this direction and no instances of nuisance or annoyance of this character have been brought to its attention which were not settled by the local boards of health, which have, for this purpose, greater executive authority than the State Board of Health.

Sanitary Statutes enacted by the Legislature of 1901.

The following laws relating to public health, and which relate to the work of both State and local boards of health, have been enacted by the Legislature of 1901.

[Chap. 104.]

An Act to provide for examination by the state board of health of the outlets of sewers, and as to the effect of sewage disposal.

Section 1. The state board of health shall annually examine all main outlets of sewers and drainage of the cities and towns of the Commonwealth, and the effect of sewage disposal, and annually report thereon to the general court, with such recommendations for the protection of the interests of persons and property as said board shall deem expedient, and for the prevention of offensive odors and objectionable conditions.

[Chap. 134.]

An Act relative to the killing and rendering of horses and other animals.

Section 1. Any person, firm or corporation engaged or desiring to engage in the business of killing horses, or in the rendering of horses or other animals, shall, within thirty days after the passage of this act, and thereafter annually in the month of March, make application to the board of health of the city or town where the business is to be conducted, for a license to carry it on. Such application shall be in writing, signed by the person or persons desiring to conduct the business, or, in the case of a corporation, by some officer thereof thereto duly authorized. It shall state the names in full and the addresses of all the persons desiring to carry on said business, or, in the case of a corporation, of all the officers thereof, and the street or other place where the business is to be conducted. No unlicensed person shall carry on the business of killing or of rendering horses or other animals.

Section 2. The board of health of a city or town may grant licenses for such killing or rendering establishments, but not till it has satisfied itself that the applicants have a suitable building and plant in a situation approved by the said board of health, and suitable trucks or wagons for the removal of dead animals; and the said board may at any time revoke any such license. The license fee shall not exceed one dollar. The license shall state the names of the licensees and the situation of the building or establishment where the business is to be carried on, and shall continue in force until the first day of April, of the year next ensuing, unless sooner revoked. The board of health of any city or town granting such licenses shall keep a record thereof, and shall also notify the board of cattle commissioners whenever any such license is granted, giving the names and addresses of the licensees.

SECTION 3. Persons licensed as aforesaid shall report to the board of cattle commissioners, in such form and at such times as the board may direct, every animal received by them which is found to be infected with a contagious disease.

SECTION 4. That part of section thirty-two of chapter four hundred and eight of the acts of the year eighteen hundred and ninety-nine providing that no person shall knowingly sell an animal with a contagious disease, shall not apply to any person selling such an animal to any person licensed as aforesaid: *provided*, that such animal is to be killed or rendered at the establishment of such licensee.

SECTION 5. Any person violating any provision of this act shall be punished by a fine not exceeding two hundred dollars or by imprisonment in jail for a term not exceeding ninety days, or by both such fine and imprisonment.

[CHAP. 138.]

AN ACT TO PROHIBIT THE TAKING OF SHELLFISH FROM CONTAMINATED WATERS.

SECTION 1. The commissioners on inland fisheries and game shall, whenever so requested in writing by the state board of health, prohibit the taking of oysters, clams, quahaugs and scallops from the tidal waters or flats of any part of the Commonwealth, for such period of time as the said board of health may determine.

SECTION 2. The state board of health shall have power to examine all complaints that may be brought to its attention in regard to contamination of tidal waters and flats by sewerage or other causes, to determine as near as may be the bounds of such contamination, and mark the same when necessary, and to request the commissioners on inland fisheries and game to prohibit the taking therefrom of any oysters, clams, quahaugs and scallops, as provided in section one of this act.

SECTION 3. Whoever takes any oysters, clams, quahaugs or scallops from any part of the tidal waters or flats of the Commonwealth from which the taking of the same is prohibited as above provided shall forfeit not less than five nor more than ten dollars for the first offence, and not less than fifty nor more than one hundred dollars for each subsequent offence: *provided*, that the commissioners on inland fisheries and game shall cause notice of such prohibition, with a description or bounds of the premises concerned, to be given by publication in some newspaper published in the town or county in which or adjacent to which are situated the tidal waters or flats from which the taking of oysters, clams, quahaugs or scallops is prohibited as above provided, at least one week before said penalty shall be incurred.

[Chap. 171.]

An Act to provide for the establishment in cities of hospitals for persons having smallpox or other diseases dangerous to the public health.

Section 1. Every city in the Commonwealth shall establish within its limits and keep itself constantly provided with one or more isolation hospitals for the reception of persons having smallpox or any other disease dangerous to the public health. Such hospitals shall be subject to the orders and regulations of the boards of health of the cities in which they are respectively located.

Section 2. Whenever a city shall refuse or neglect to carry into effect the provisions of section one of this act, after having been requested so to do by the state board of health, it shall be liable to forfeit a sum not exceeding five hundred dollars for each refusal or neglect.

[Chap. 188.]

An Act relative to the manufacture and sale of textile fabrics and papers containing arsenic.

Section 1. Section one of chapter three hundred and twenty-five of the acts of the year nineteen hundred is hereby amended by inserting after the word "to", in the ninth line, the words: — articles intended for the destruction of insects, having the word "Poison" plainly printed in uncondensed gothic letters not less than one inch long on both sides of each sheet and square foot of the fabric, or to, — so as to read as follows: — *Section 1.* Any corporation, person, firm or agent who directly or by an agent manufactures, sells, exchanges, or has in his custody or possession with intent to sell or exchange, any woven fabric or paper containing arsenic in any form, or any article of dress or of household use composed wholly or in part of such woven fabric or paper, shall on conviction thereof be punished by fine of not less than fifty nor more than two hundred dollars: *provided, however*, that this section shall not apply to articles intended for the destruction of insects, having the word "Poison" plainly printed in uncondensed gothic letters not less than one inch long on both sides of each sheet and square foot of the fabric, or to dress goods or articles of dress containing not more than one one hundredth grain, or to other materials or articles containing not more than one tenth grain of arsenic per square yard of the material.

[Chap. 313.]

An Act to authorize the temporary taking of water for emergency purposes by cities and towns.

Section 1. Cities by their city councils, and towns having a system of water supply by their water commissioners or selectmen, may in cases of emergency and for a period not exceeding six months in any one year, take water from any brook, stream, river, lake, pond or reservoir, not already appropriated to uses of a municipal water supply, in such quantities as may be necessary to relieve the emergency; but water commissioners or selectmen of towns shall not make any such taking unless previously authorized so to do at some meeting of the inhabitants of the town regularly called therefor. They may also take such rights to use any land and for such time as may be necessary to use such water. Such vote of a city council or of a town meeting shall be conclusive as to the existence of the emergency. No such taking shall be made until the state board of health shall have first approved the water as a proper source of water supply.

Section 2. The city councils of cities and the water commissioners or selectmen of towns shall cause to be recorded in the registry of deeds for the county or district in which such water and land are situated, within thirty days after the taking, a description sufficiently accurate for identification, with a statement of the purpose and the time for which the same are taken, which statement shall be signed by the mayor of the city or by the chairman of the water commissioners or selectmen of the town making the taking, and upon such recording the right to use for the time stated in such taking shall vest in such city or town.

Section 3. The city councils of cities and the water commissioners or selectmen of towns shall within sixty days after the termination of the exercise of any right taken under the provisions of this act estimate and determine, as near as may be, the actual damages sustained by any person by the taking of any water and of the right to use any land under this act; but any one aggrieved by such determination may have such damages assessed by a jury of the superior court, in the same manner as is provided by law with respect to damages sustained by the laying out of ways. If upon trial damages are increased beyond the amount determined as aforesaid, the aggrieved person shall recover costs, otherwise such person shall pay costs, and costs shall be taxed as in civil cases; but no suit or petition for such damages shall be brought after the expiration of two years from the date of the recording of the description and statement as aforesaid.

Section 4. The powers conferred upon and the duties to be performed by the city councils and mayors of cities under this act shall within those cities and towns using the metropolitan water supply be exercised by the metropolitan water and sewerage board.

[Chap. 341.]

An Act relative to the sale of articles of food and drink which contain antiseptic or preservative substances.

Section 1. Every article sold as an article or ingredient of food or drink that contains any added antiseptic or preservative substance, except common table salt, saltpetre, cane sugar, alcohol, vinegar, spices, and in smoked food the natural products of the smoking process, shall be deemed to be adulterated within the meaning of chapter three hundred and forty-four of the acts of the year eighteen hundred and ninety-seven, unless every package of such article sold or offered for sale bears a label on which are clearly indicated the presence and the percentage of every such antiseptic or preservative substance.

Section 2. The foregoing provision shall not apply to such portions of suitable preservative substances as are employed as a surface application for preserving dried fish or meat, or to such preservative substances as exist in animal or vegetable tissues as a natural component thereof, but shall apply to additional quantities.

Section 3. This act shall be construed as in addition to and not superseding or annulling any of the provisions of existing laws.

Section 4. Within sixty days after the passage of this act the state board of health shall take such measures as the board may deem sufficient to make the provisions of the act known to the persons who may be affected thereby.

Section 5. Goods held in stock by retail dealers prior to the date of taking effect of this act, if proved to have been so held, shall be exempt therefrom during the first year of the operation of this act.

Section 6. Section four of this act shall take effect upon its passage, and the remainder of the act shall take effect on the first day of January in the year nineteen hundred and two.

[Chap. 396.]

An Act relative to the labelling of certain articles of food and drink.

Section 1. In every case where a statement of any of the ingredients is required by law to be announced upon the label of an article of food or drink, or of an article entering into food or drink, such statement and the name and address of the manufacturer or vendor of the article shall be distinctly and conspicuously printed on the label in straight, parallel lines of plain, uncondensed, legible type, well spaced on a plain ground. The statement of ingredients shall be clearly separated from and not interspersed or confused with other matter, shall specify every such ingredient by its

ordinary name, and shall be in the English language. The letters of said type shall be not less than one twelfth of an inch long, and shall be larger than those of any other printed matter on the label or package, except that the name of the compound or chief article enclosed therein may be in larger type. The required label shall be firmly attached to or printed on the exterior of the package or envelope of the said article, on the top or side thereof and in plain sight.

Section 2. The state board of health may in writing approve specific labels not strictly in accordance with the provisions of section one, if they deem that the information required by law is set forth thereon clearly enough for the reasonable protection of the purchaser.

Section 3. Except as otherwise provided in section two goods labelled in violation of section one hereof shall be subject to the same provisions of the laws relative to adulteration of food which would apply to them if unlabelled.

Section 4. Within sixty days after the passage of this act the state board of health shall take such measures as the board may deem sufficient to make the provisions of the act known to the persons who may be affected thereby.

Section 5. Goods held in stock by retail dealers prior to the date of taking effect of this act, if proved to have been so held, shall be exempt therefrom during the first year of the operation of this act.

Section 6. This act shall be construed as in addition to and not as superseding or annulling any of the provisions of existing laws relative to the labelling of articles of food or drink.

Section 7. Section four of this act shall take effect upon its passage, and the remainder of the act shall take effect on the first day of January in the year nineteen hundred and two.

Chapter 427 of the Acts of 1901 provides for the abatement of the smoke nuisance but does not treat the subject as one of sanitary importance, the supervision of this matter being placed by the terms of this act in charge of the mayor and aldermen of cities and the selectmen of towns.

Cremation.

Under the provisions of chapter 265 of the Acts of 1885, as amended by chapter 101 of the Acts of 1886, the State Board of Health is authorized to approve the location and plans of crematories intended for the incineration of the dead, together with the by-laws and regulations adopted for the conduct of such establishments.

Under these statutes the president of the proprietors of Mount Auburn Cemetery submitted a proposed location, with the plans,

by-laws and regulations, for a crematory at Mount Auburn Cemetery, Jan. 16, 1900. The Board, after examining the same, replied as follows: —

APRIL 7, 1900.

I. M. SPELMAN, *President of the Proprietors of Mount Auburn Cemetery, Cambridge, Mass.*

DEAR SIR: — I have the honor to inform you that in compliance with your request of Jan. 16, 1900, this Board has caused the crematory at Mount Auburn to be examined, and the proposed location and plans, together with the details of construction are hereby approved by the Board.

The Board has also examined the by-laws and regulations proposed for the reception and cremation of bodies of deceased persons and for the disposition of the ashes remaining therefrom, and finds them consistent with the statutes and they are therefore approved by this Board.

By order of the State Board of Health,

SAML. W. ABBOTT,
Secretary.

The Transportation of Corpses.

During the past year a considerable number of certificates have been received from express companies granting permission for the transportation of corpses from other States to Massachusetts. This question has been made the subject of much legislation and of many regulations in other States, especially in the west; but in Massachusetts the only law having reference to the transportation of corpses is the following: —

[ACTS OF 1897, CHAPTER 437, SECTION 6.]

SECTION 6. No railroad corporation or other common carrier or person shall convey or cause to be conveyed, through or from any city or town in this Commonwealth, the remains of any person who has died of smallpox, scarlet fever, diphtheria or typhus fever, until such body has been so encased and prepared as to preclude any danger of communicating the disease to others by its transportation; and no city or town clerk, or clerk or agent of the board of health, shall give a permit for the removal of such body until he has received from the board of health of the city or from the selectmen of the town where the death occurred a certificate stating the cause of death, and that said body has been prepared in the manner set forth in this section, which certificate shall be delivered to the agent or person who receives the body. Any person violating the provisions of this section shall forfeit not exceeding twenty-five dollars.

This statute appears to be nearly identical with that of 1887, chapter 335, the words *typhus fever* having been substituted for *typhoid fever* during the process of legislation.

The Pan-American Exhibit at Buffalo.

On Aug. 28, 1900, a letter was received by the Board from Dr. Jacob S. Otto, assistant superintendent of the proposed exhibit of sanitation at the Pan-American Exposition at Buffalo in 1901, informing the Board of a proposed exhibit of sanitation at that time and place.

On Nov. 1, 1900, another communication was received from Dr. Otto, notifying the Board that the material which had been exhibited by the Board at the Paris Exposition was to be returned to this country, and at the same time requesting that the same material might be sent to Buffalo for exhibition there. Accordingly the exhibit was transferred to Buffalo, on condition that it be returned to the State Board of Health at the close of the exposition.

The Pathological Department of the Board.

The bacteriological work which is necessitated by the constant prevalence of infectious diseases throughout the State has been conducted throughout the year mainly at the laboratory at Forest Hills, under the charge of Dr. Theobald Smith, as in previous years since 1894. The work of this department has constantly increased since the first year in which it was organized, notwithstanding the fact that in several cities and large towns similar departments have been established where such work has been carried on under the direction of local boards of health. A brief summary of this work of local boards of health is presented in another portion of this report.

The different lines of work conducted in the pathological department during the year 1900 have been the following: —

1. The production of antitoxin, which has comprised the preparation of 53,389 vials of antitoxin during the year ended March 31, 1901.

2. The examination of 5,173 cultures of matter suspected of containing the germs of diphtheria.

3. The examination of 746 specimens of material suspected of containing germs of tuberculosis.

4. The examination of specimens of blood of persons living in malarial districts.

5. Examination of the blood of typhoid patients.

The following brief table shows the number of specimens ex-

amined for the presence of the germs of diphtheria and tuberculosis since the organization of the department: —

	Diphtheria.	Tuberculosis.
1896,	1,469	124
1897,	2,204	236
1898,	1,591	414
1899,	3,258	571
1900,	5,173	746
Totals,	13,695	2,091

It is quite desirable that local laboratories should be established in cities and towns at distances remote from the office of the Board, in order that the rapidity of diagnosis may be facilitated. A commendable movement has been made in Springfield, where a local physician has established a well-equipped private laboratory, where bacteriological work is done not only for the city of Springfield but also for the local boards of health of other cities and towns within a radius of forty or fifty miles.

Water Supply and Sewerage.

The work of this department has been carried on in this, as in previous years, under the direction of the Engineer of the Board. During the year 1900 the Board has received 104 applications for advice with reference to water supply, sewerage and drainage and the prevention of the pollution of streams, under the provisions of chapter 375 of the Acts of 1888, entitled "An Act to protect the purity of inland waters and to require consultation of the State Board regarding the establishment of systems of water supply, drainage and sewerage," and under the provisions of other acts relating to these subjects. This number of applications has been greater than in any previous year, and was about double the number presented to the Board for consideration in any year previous to 1896. Public hearings have been given by the Board in connection with several of these matters. A report upon the work done under the provisions of chapter 375 of the Acts of 1888 has already been presented to the Legislature, in Senate Document No. 182, dated Jan. 10, 1901, and the abstracts of replies of the Board to various applications are given in pages 1 to 103 of this report.

Examination of Water Supplies.

The various public water supplies in the State have been examined from time to time, and the results of the chemical and microscopical examinations are presented in the tables beginning on page 123. In some cases where little change was found in the quality of the water from month to month an average of several chemical analyses is presented, and the microscopical analyses are omitted. At the end of the year 166 cities and towns were provided with public water supplies, 116 being supplied from their own works and 50 from private companies. The total population in the cities and towns supplied, according to the census of 1900, was 2,565,301, or 91.4 per cent. of the total population of the State. The population of places supplied by private companies amounts to 237,917, or about 9.3 per cent. of the total population in all the cities and towns supplied.

Rivers.

Numerous samples of water from various points on the more important streams were analyzed, as in the previous year, the results of which are given in subsequent pages of this report. The flow of streams in 1900 was very greatly in excess of the normal during the months of February, March and May, but in all the remaining months of the year it was less than the normal, and during the summer the flow of streams became very low, especially in August and the early part of September. No material change has been made in the conditions at any of the places referred to in the last report where streams are highly polluted. The condition of the Blackstone River remains practically the same as in the previous year. The Neponset River during 1900 was even more objectionable than in previous years, and the odor from the stream, which in the lower portion of its course flows through a populous district, was exceedingly foul throughout its entire length below Walpole. The sewage of the city of Pittsfield is still discharged into the Housatonic River, though plans are being prepared for the purification of this sewage.* Plans are under consideration for the sewage of the city of Fitchburg, which is now discharged directly into the north branch of the Nashua River, greatly polluting the stream. At Middlebor-

* The construction of works for the purification of the sewage of Pittsfield was begun in the early part of 1901.

ough the sewage of the town continues to be deposited in a long open ditch and a long raceway, whence it finds its way into the mill ponds along the river, in which the solid matters are deposited and decompose.

The usual tables of water supply statistics are presented.

Purification of Sewage and Water.

At the Lawrence Experiment Station investigations upon the purification and disposal of sewage by various methods have been continued, and the results are presented in detail in the report of the chemist of the Board. The investigations upon the purification of sewage have dealt chiefly with the purification of sewage at rapid rates by methods adapted to fit conditions in which suitable land and soil for the purification of sewage are not available. The investigations with regard to the removal of bacteria from water by sand filters upon an experimental scale and by the Lawrence city filter have been continued. Special studies have been made of the methods of determining the presence of *B. coli communis* in the water of the Merrimack River and relative to the removal of this organism from the water by filtration, and the significance of the presence of these organisms in the effluents from sand filters. Important studies have also been made upon the removal of color, taste and odor from natural waters, frequently the cause of complaint of the quality of the water of many public water supplies. Investigations upon the action of water upon metallic service pipes used in connection with public water supplies have been continued as in previous years, the results of which are presented by the chemist, together with a study of the methods employed for the separation and determination of the various metals found in the water taken from such pipes.

Examination of Ice.

During the past year many applications have been made to the Board for advice relative to sources of ice supply and relative to the quality of ice taken from various ponds and streams in the State, and one of the most important investigations made by the Board during the year relates to the effect of the freezing of water upon its chemical constituents and upon the bacteria present therein, the results of which are presented in a report by the chemist of the Board. Experiments upon the freezing of water containing various kinds of bacteria and polluted to different degrees by sewage, taken

in connection with the results of many examinations of ice from ponds and streams, tend to confirm the conclusions reached in an earlier investigation made by the Board by direction of the Legislature in the year 1889. The results of all the studies have made it evident that the conditions affecting ice when it freezes have a very important influence upon its purity. Where the water upon which the ice forms is not shallow and has not too rapid motion, with but little matter in suspension, the matters contained in the water, together with the bacteria, are likely to be removed from the water in as complete a degree as would be effected in ordinary distillation; but a considerable part of the impurities in the water near the surface, especially the floating matters, may become entangled in the first inch or less of ice that forms upon the pond. If snow falls upon the ice, causing it to sink so that water from below saturates the snow, it will freeze without purification, or if rain falls upon snow lying over the ice, the ice thus formed contains the impurities of the snow and of the rain water, or any water which may have flowed over the ice upon the pond. Where water freezes in shallow places also, or where weeds or other matters from the bottom of the pond are included in the ice, impurities taken from the bottom or from these objects may be found in the ice. The results of the investigations as a whole lead to the conclusion that it is in general unsafe to use ice from a polluted source; but the investigations thus far made indicate that pure ice may be obtained, under some circumstances, from a polluted source, where the water when freezing is not shallow and has not too rapid motion, by removing from the ice when harvested the first inch that formed upon the pond and all of the ice which may have formed above the first inch from snow, rain or flooding, and retaining for use only the clear ice beneath the first inch which formed.

Examinations of Spring Waters.

In the year 1891 an examination was made by the Board of the spring waters offered for sale in the State, which were found to number 45. During the year 1900 the spring waters offered for sale in the State were again examined under the direction of the Engineer of the Board, and it was found that the number had more than doubled since the previous examination, the total number found in use being 99. The total sales of all spring waters apparently exceed 6,000,000 gallons per year, and the amount of money paid for

spring waters in the cities and towns of the State during the year appears to have exceeded $300,000. The results of the analyses of these waters are presented in a subsequent portion of this report. In the former examination, water from the source only was examined; but in the recent examinations, samples of water were collected both from the source and as the water was being delivered to consumers, to learn whether the water was in any way affected by the processes of collection and distribution. The results of all the examinations show that there is in general a deterioration in the quality of the water as delivered to consumers from its condition as found at the source from which the water was taken. This deterioration is apparently due in some cases to the addition of some mineral ingredient to the water; but the large increase which in many cases is noted in the numbers of bacteria in the water as delivered to consumers over the number found at the sources of supply is an indication of lack of care and cleanliness in its collection and distribution. The colon bacillus was found in several of the samples examined, indicating the presence of fæcal matter in these waters, and the examinations, on the whole, show the need of much more care in the cleansing and filling of the receptacles in which the water is delivered to consumers. A very large number of the spring waters were found to be of high purity, though no purer than the water of the best of the public water supplies of the State taken from ground sources, which have also the advantage that they are far less liable to become seriously polluted before reaching the consumer than are the spring waters. In the cities and towns supplied with good ground waters the sales of spring waters were found to be small, while in those cities and towns supplied with surface waters affected by a high color, or an occasional bad taste or odor, the sales were large. In many places of the latter class spring water is evidently deemed a necessity, especially by the mill operatives in warm weather, but is purchased also by a large proportion of the people, who tax themselves a considerable sum in the aggregate to furnish a palatable drinking water which should be supplied by the public works.

Water Consumption.

The records which have been kept by various municipalities and water companies of the quantity of water supplied to cities and towns, together with information as to the number of taps, meters, etc., have been supplied to the Board by the water works authori-

ties, and since they are of much value they are presented in a paper entitled "Consumption of Water in Cities and Towns," prepared by the Engineer of the Board. While the growth of population in cities and towns in the State in recent years has in general been rapid, the increase in the consumption of water, as a comparison of the tables for the different years will show, has been even more rapid than the growth in population, and the limit does not as yet appear to have been reached. It has been the custom, in most cases when a system of water works has been introduced into a city or town, to base the charges for the use of water upon the number and kind of fixtures in the houses or buildings to be supplied, and sometimes upon the value of the buildings. More recently the custom of measuring the water supplied to large consumers through meters, and charging a fixed rate in proportion to the quantity of water used, has come into practice, and at the present time this system is being extended in many places so as to include all consumers of water from the public works. In many places where the water supplied to the municipality is pumped, and the records of the pumping are kept, a comparison of these records with the measured quantity of water sold through meters shows a large difference, the quantity of water pumped often being nearly twice as great as the quantity measured by the meters. Errors in measurement may account for much of this difference, or it may be due to an excessive loss of water by leakage. Nevertheless, the effect of measuring the water sold to consumers has, in the first instance, been to check the increase in the consumption of water in a large number of cases.

It is interesting to note that, coincident with the movement to reduce the consumption of water from public works by more exact methods of distributing the water, there has been a marked increase in the number of private water supplies in the State. Many applications have been received by the Board during the past year from manufacturers and other large consumers of water for advice with reference to the quality of the water of sources from which it was proposed to supply a large number of operatives, and in many cases also tenement houses under the control of a manufacturing firm or corporation. Many of the waters proposed for use in these cases are drawn from the ground in thickly built up communities, and give evidence, upon analysis, that they have been at some time polluted to a greater or less degree by sewage, and are unsafe for drinking.

Report of the Board upon the Discharge of Sewage into Boston Harbor.

Under the provisions of chapter 65 of the Resolves of 1899, the Board was directed to consider the subject of the discharge of sewage into Boston harbor and the disposal of the sewage of the metropolitan district, and to report a plan for an outlet for a high-level, gravity or other sewer for the relief of the Charles and Neponset River valleys. Acting under this resolve, the Board submitted the following report to the Legislature, April 18, 1900: —

By chapter 65 of the Resolves of the General Court of Massachusetts of 1899, the State Board of Health is directed to consider the general subject of the discharge of sewage into Boston harbor and the disposal of sewage for the metropolitan districts of the Commonwealth, and to report a plan for an outlet for a high-level, gravity or other sewer for the relief of the Charles and Neponset River valleys.

Sewage is now discharged into Boston harbor at two points, one being at the northern limit of the outlet of the harbor near Deer Island Beacon, and the other in a more central position nearer the main land on the north side of Moon Island.

At the outlet near Deer Island Beacon, which is $4\frac{3}{8}$ miles from Long Wharf in Boston, and in the northerly edge of the main ship channel, sewage from the north metropolitan district is allowed to discharge as it comes at all stages of the tide. The quantity of sewage discharged in twenty-four hours now reaches about 50,000,000 gallons; and this quantity, while distinctly visible along the northerly edge of the channel for a half mile toward the city on the incoming tide and toward the sea on the outgoing tide, gradually becomes less distinct at greater distances from the outlet, and disappears entirely within a distance of $1\frac{1}{4}$ miles.

With the increase of population in the north metropolitan district, the amount of sewage discharged will increase and will spread over a somewhat larger area; but the Board sees no reason to anticipate any trouble from this for many years in the future upon any habitable shores, and believes that the only objection that can be raised to the continual discharge of sewage here will be by those sailing through or near to the stream of sewage within a mile of the outlet.

At Moon Island is now discharged sewage from the main drainage works of Boston, including that from the lower valley of Charles River and from a part of Neponset River valley, amounting to a maximum of about 100,000,000 gallons a day. This outlet is about $1\frac{3}{4}$ miles farther west than the outlet at Deer Island Beacon, and much nearer the main land, and so

situated that if sewage were allowed to discharge upon the incoming tide it would be brought to habitable shores and become a nuisance; for this reason the sewage is conveyed to reservoirs on Moon Island during the incoming tide and discharged only during certain hours of outgoing tide, when the currents are most favorable for conveying the sewage-laden water toward the sea through channels which render its passage the least objectionable.

By storing sewage in reservoirs, even for the hours between tides, it becomes more offensive; and the large amount which must be discharged in the short time of favorable outgoing currents renders the locality of the outlet and the surrounding area of a half-mile radius much more objectionable than the steady discharge of fresh sewage at Deer Island Beacon. These conditions limit the amount of sewage that may be concentrated at this point without creating a nuisance.

The tunnel connecting Old Harbor Point and Squantum in the line of the Boston main drainage system has a maximum capacity for conveying about 150,000,000 gallons of sewage per day; and this is about the amount of sewage that may be expected forty years hence from the low-level area of Boston, for which these works were designed. This amount will be about 50 per cent. more than the present maximum discharge, and, in the opinion of the Board, this should be regarded as about the maximum amount that can be concentrated at Moon Island outlet without giving unreasonable offence.

We think the Metropolitan Sewerage Commissioners have done well in seeking another outlet for the south metropolitan system, with the view of ultimately removing from the Moon Island outlet all of the areas now drained which were not contemplated in the original design for the low-lying area of Boston. With the limitation above indicated, we regard the outlet at Moon Island a suitable point of discharge for the sewage of the low-lying portion of Boston.

From a careful study of the channels and currents of the harbor and of the whole area which may in future be included in the south metropolitan system, we conclude that the Metropolitan Sewerage Commissioners, in their report upon a high-level gravity sewer, of Feb. 11, 1899, have designated the channel in the harbor best suited to receive the sewage of the south metropolitan system, viz., the channel along the north-westerly side of Peddock's Island; but after an extended study of the locality, we would advise moving the outlets they propose about 2,000 feet further north, so that both will be one mile from Nut Island, one directly north from the middle thereof and the other 1,500 feet more easterly, as indicated upon the plan. Here the sewage will be discharged about 30 feet below the surface at low tide into a strong and deep current, by which it will be kept well away from inhabited shores until it disappears by commingling with enormous quantities of ever-changing salt water.

The paths that will be taken by the sewage discharged at these points, with their limitations upon varying conditions of wind and tide, are shown upon the maps of the accompanying report of the chief engineer of the Board; and, from a study of the actual conditions existing at the present outlets, we conclude that the sewage of the south metropolitan system can be discharged at these points continuously without offence except to those who are sailing in the stream of mingled sewage and water, or near its leeward side within a mile of the outlets, and that they are the most suitable points for the discharge of the sewage of the south metropolitan system.

The plan of outlet designated on pages 77 and 78 of the report of the Metropolitan Sewerage Commissioners of Feb. 11, 1899, to the General Court, with the change of position herein presented, is recommended for adoption by this Board.

In considering the general subject of the disposal of sewage for the metropolitan districts of the Commonwealth, as required by the resolve, question has arisen as to what areas were intended to be included in this study. There are areas north and north-east from the north metropolitan sewerage system which are nearer to Boston than some of the areas which have been considered; but, as the question of discharge of sewage into Boston harbor from these territories is not likely to arise, except for some small areas which may become adjuncts to the north metropolitan system, for which provision is made under existing laws, no consideration is given to these areas in this report; but examination has been made of all territory in regard to which may arise question as to whether its sewage had better be discharged into Boston harbor.

After a very complete study of all of the towns of the upper Charles and Neponset River valleys, a brief statement of which is given in the accompanying report of the chief engineer of the Board, it was found that, with few exceptions, to be mentioned, it will be more economical to dispose of the sewage of these towns (which are not designated by law as belonging to one of the metropolitan districts) by filtration upon land in each town, or by a combination of two or more towns, than by conveying it to Boston harbor. The exceptions are areas of small extent in the towns of Wellesley, Needham and Weston, lying near to Charles River, the sewage from which can be conveyed across the river and into the Newton main sewer and thence to the Charles River valley sewer of the metropolitan system.

These are the only additions that it may be well to make in this direction to the south metropolitan system.

South from Quincy and east from Canton are the towns of Randolph, Holbrook, Braintree, Weymouth and Hingham, whose natural drainage is into Boston harbor. Randolph and Holbrook, when they need to dispose of sewage, can do so economically upon land within their respective territories; but Braintree, Weymouth and Hingham can best discharge their

sewage into the sea through the outlets of the high-level sewer. Plans by which this may be accomplished are presented in the report of the chief engineer of the Board.

The change of the outlet herein recommended does not require the presentation of a bill for action by the General Court; because chapter 424 of the Acts of 1899, section 1, provides that no part of said proposed outlet shall be constructed until plans of said outlet shall be further considered by the Metropolitan Sewerage Commissioners and adopted and approved by the State Board of Health.

It is further provided, by section 2 of the same act, after describing the limits of the south metropolitan system, that "nothing herein shall be construed to vest any rights which cannot be extended to cities and towns or parts thereof other than those herein named, upon such terms and conditions as may hereafter be imposed by legislative enactment;" and, as the sections of the towns of Wellesley, Needham and Weston, and the towns of Braintree, Weymouth and Hingham, which are not now included in the south metropolitan system, can under this section be admitted into the system when they may in the future need to dispose of their sewage, and they can then be allowed to enter without modification of the works already planned, it does not appear necessary or expedient to prepare a bill at this time under which they may then enter.

HENRY P. WALCOTT,
HIRAM F. MILLS,
FRANK W. DRAPER,
GERARD C. TOBEY,
JAS. W. HULL,
CHAS. H. PORTER,
JULIAN A. MEAD,
State Board of Health.

ROUTINE WORK OF THE BOARD.

During the year ended Sept. 30, 1900, the Board held meetings at least once in each month. Meetings of such of the standing committees as were necessary for the transaction of business were also held from time to time. Hearings were held at the office of the Board relative to the sewage disposal of Longmeadow (February 1) and Swampscott (March 1), also with reference to the sanitary condition of the Concord and Sudbury rivers (September 6).

Visits were also made by the full Board to the Concord and Sudbury rivers July 16, and to the proposed location of the outlets of the high-level sewer in Boston harbor April 28.

The office of the Board has been open throughout the year, as pre-

scribed by the Public Statutes, chapter 21, section 10,* for the transaction of its authorized business.

Advice has been very frequently given at the office and by mail to local boards and to individuals in regard to sanitary matters, and many visits have been made by the secretary, the inspector, the engineers and other experts to cities and towns for the purpose of making investigations and giving advice.

The bacteriological work undertaken by the Board for the benefit of such communities in the State as possessed no facilities for such methods of investigation and diagnosis, together with the production and distribution of antitoxin for the treatment and prevention of diphtheria, has very materially increased the work of the office, which acts as a general and central station for the distribution of antitoxin, and of the various culture tubes, receptacles and other means employed for the diagnosis of disease.

The following table presents certain statistical data relative to the routine work of the Board: —

Statistical Table for the Year ended Sept. 30, 1900.

Whole number of samples of foods and drugs examined during the year,	10,122
Samples of milk examined (included in the foregoing),	6,232
Whole number of samples of food and drugs examined since beginning of work in 1883,	117,514
Whole number of samples of milk examined since beginning of work in 1883,	63,616
Number of prosecutions against offenders during the year,	94
Number of convictions during the year,	89
Amount of fines imposed during the year,	$1,890 70
Number of packages of antitoxin of 1,500 units each issued to cities and towns,†	53,389
Number of bacterial cultures made for the diagnosis of diphtheria in cities and towns,†	5,173
Number of examinations made for diagnosis of tuberculosis,†	746
Number of examinations of blood made for diagnosis of malarial infection,†	78
Number of examinations of blood made for the diagnosis of typhoid fever,	62
Number of notices of cases of infectious diseases received and recorded under the provisions of chapter 302, Acts of 1893,‡	32,615
Number of postal-card returns of mortality for cities and towns received and recorded,‡ about	2,000
Number of annual reports of cities and towns received under the provisions § of Acts of 1894, chapter 218,‡	94

* Office hours, 9 A.M. to 5 P.M.; Saturdays, 9 A.M. to 2 P.M. † For the year ended March 31, 1901.
‡ For the calendar year 1900. § Cities and towns having a population of more than 5,000 in each.

Force employed in general work of Board at central office, State House: —	
Secretary,	1
Clerks,	3
Messenger,	1
Total,	5
Force employed at central office, State House, Boston, for food and drug inspection, chemists and assistants,	2
At Amherst,	1
Inspectors,	4
Total,	7
Force employed at laboratory (Bussey Institute): —	
Pathologist,	1
Assistants,	5
Total,	6

Under the Provisions of Chapter 375, Acts of 1888.

Applications for advice from cities, towns and others: —	
Relating to water supply,	53
Relating to ice supply,	13
Relating to sewerage and drainage,	28
Relating to pollution of streams,	9
Miscellaneous,	1
Total,	104

Number of samples of water examined chemically and microscopically at the laboratory, Room 502, State House,	3,260
Number of samples of sewage and effluent from sewage purification works examined chemically at the laboratory, Room 502, State House,	1,189
Number of samples of sewage and water examined chemically and bacterially at the Lawrence Experiment Station,	2,067
Number of samples of sand examined chemically and bacterially at the Lawrence Experiment Station,	54
Number of samples of sand examined mechanically at the Lawrence Experiment Station,	85
Number of gas analyses at the Lawrence Experiment Station,	120
Number of samples examined for B. coli communis at the Lawrence Experiment Station,	4,636
Additional samples examined bacterially at the Lawrence Experiment Station,	4,869
Total number of samples examined,	16,280

Force employed at central office: * —

Chief engineer,	1	
Assistant engineers,	4	
Stenographers and clerks,	2	
Messenger,	1	
		8

At laboratory, Room 502, State House: —

Chemist,	1	
Assistant chemists,	5	
Biologist,	1	
Stenographer,	1	
		8

At Lawrence Experiment Station: —

Assistant chemists,	2	
Bacteriologists,	2	
Other assistants and laborers,	3	
		7
Total ordinary force,		23

The number of applications for advice under the provisions of the acts relating to water supply and sewerage, received since July, 1886, when these acts first went into operation, is as follows: —

1886,	8	1895,	52
1887,	22	1896,	65
1888,	28	1897,	59
1889,	38	1898,	75
1890,	23	1899,	79
1891,	53	1900,	104
1892,	56		
1893,	51	Total,	766
1894,	53		

Appropriations.

The appropriations for the year 1900, as recommended by the Board in the annual estimates made under the provisions of chapter 41 of the Acts of 1885, were as follows: —

For the general expenses of the Board,	$23,000 00
For the inspection of food and drugs,	11,500 00
For the protection of the purity of inland waters,	30,000 00
Total,	$64,500 00

* Not including force employed under provisions of chapter 65 of Resolves of 1899.

Expenditures.

The expenditures in 1900 under the different appropriations were as follows : —

Appropriation for general expenses of Board,		$23,000 00

General Expenditures, Sept. 30, 1899, to Sept. 30, 1900.

Salaries,	$9,644 06	
Travelling expenses,	1,009 86	
Stationery,	395 57	
Printing,	1,167 34	
Books, subscription and binding,	402 26	
Advertising,	43 44	
Express charges,	200 04	
Extra services,	152 02	
Messenger services,	60 69	
Postage and postal orders,	494 98	
Telephone and telegraph messages,	91 77	
Typewriting supplies,	64 75	
Special investigations,	37 70	
Sundry office supplies and incidental expenses,	922 67	
Laboratory supplies,	277 82	
		$14,964 97

Expenditures at Pathological Laboratory at Forest Hills.

Salaries,	$2,710 62	
Travelling expenses,	11 37	
Purchase of animals,	184 17	
Board of horses,	1,685 61	
Food for animals,	86 43	
Apparatus, chemicals and laboratory supplies,	1,006 42	
Ice,	21 33	
Postage,	1 37	
Stationery,	4 03	
Rental of telephone and messages,	129 70	
Express,	37 24	
		5,878 29
Total,		$20,843 26

Under the Provisions of the Food and Drug Acts during the Year ending Sept. 30, 1900.

Appropriation,	$11,500 00
Salaries of analysts,	$4,400 00
Salaries of inspectors,	4,000 00
Amount carried forward,	$8,400 00

Amount brought forward,	$8,400 00
Travelling expenses and purchase of samples,	1,800 00
Apparatus and chemicals,	275 80
Printing,	9 11
Special investigations,	35 00
Extra services for inspection,	242 00
Services (cleaning laboratory),	103 51
Express,	4 93
Sundry laboratory supplies,	129 97
Books,	75 20
Stationery,	20 70
Extra services (stenographer),	12 51
Total,	$11,108 73

Appropriation.

For carrying out the provisions of the act to protect the purity of inland waters, and to require consultation with the State Board of Health regarding the establishment of systems of water supply, drainage and sewerage,	$30,000 00
Salaries, including wages of laborers at Lawrence Experiment Station,	$24,303 84
Apparatus and materials,	2,276 11
Rent of Lawrence Experiment Station,	150 00
Use of tools and office, Lawrence Experiment Station,	206 99
Travelling expenses,	1,373 97
Express charges,	970 86
Books, stationery and drawing materials,	203 30
Maps and blue-prints,	96 19
Postage stamps,	46 00
Printing,	103 96
Collecting samples,	28 20
Messengers, telegrams and telephone messages,	14 03
Services, reading gauges,	196 40
Analysis of gas and air,	25 00
Total,	$29,994 85

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Water Supply and Sewerage.

ADVICE TO CITIES AND TOWNS.

ADVICE TO CITIES AND TOWNS.

Under the provisions of chapter 375 of the Acts of 1888, entitled "An Act to protect the purity of inland waters, and to require consultation with the State Board of Health regarding the establishment of systems of water supply, drainage and sewerage," the Board is required

"from time to time to consult with and advise the authorities of cities and towns, or with corporations, firms or individuals either already having or intending to introduce systems of water supply, drainage or sewerage, as to the most appropriate source of supply, the best practical method of assuring the purity thereof or of disposing of their drainage or sewage, having regard to the present and prospective needs and interests of other cities, towns, corporations, firms or individuals which may be affected thereby. It shall also from time to time consult with and advise persons or corporations engaged or intending to engage in any manufacturing or other business, drainage or sewage from which may tend to cause the pollution of any inland water, as to the best practicable method of preventing such pollution by the interception, disposal or purification of such drainage or sewage: *provided*, that no person shall be compelled to bear the expense of such consultation or advice, or of experiments made for the purposes of this act. All such authorities, corporations, firms and individuals are hereby required to give notice to said Board of their intentions in the premises, and to submit for its advice outlines of their proposed plans or schemes in relation to water supply and disposal of drainage and sewage; and all petitions to the Legislature for authority to introduce a system of water supply, drainage or sewerage shall be accompanied by a copy of the recommendation and advice of the said Board thereon."

During the year 1900 the Board has given its advice to the following cities, towns, corporations and individuals who have applied for such advice under the provisions of the general act of 1888, or under special acts relating to water supply and sewerage.

Official communications were made during the year under the provisions of acts relating to water supply as follows : —

Acton.
Adams.
Attleborough (S. O. Bigney & Co.).
Ayer (two).
Beverly (two).
Blackstone.
Boston (penal institutions).
Dartmouth (Bay View).
Dracut (American Woolen Company).
Gloucester (two).
Grafton.
Hardwick (Gilbertville).
Haverhill (three).
Holyoke (the Deane Steam Pump Company).
Hyde Park.
Lenox.
Lincoln.
Lowell (three).
Ludlow (Ludlow Manufacturing Company).
Massachusetts Reformatory (Concord).
Newton (Woodland Park Hotel).
Northampton.
Northampton Insane Hospital.
Northfield.
Norwood (two).
Orange.
Peabody (two).
Southborough (St. Mark's School).
Southbridge (American Optical Company).
Southbridge (Dexter Harrington & Son).
Springfield (two).
Tufts College.
Wareham, Marion and Mattapoisett.
Wenham and Hamilton (two).
West Springfield (the Southworth Company, Mittineague).
Winchendon (White Bros.).

Official communications were made during the year under general and special acts relating to sewerage and sewage disposal, as follows : —

Barnstable (State Normal School at Hyannis, two).
Brockton (Douglas Shoe Factory).
Chicopee (three).
Concord (American Woolen Company).
Fairhaven (two).
Gardner (two).
Hingham.
Holyoke.
Longmeadow.
Medfield Insane Asylum.
Metropolitan Sewerage Commissioners.
Northbridge (Whitin Machine Works).
Pittsfield (three).
Plymouth.
Sheffield.
Swampscott.
Templeton (Hospital Cottages for Children at Baldwinville).
Tisbury (drainage of a hotel).
Wellesley College.
Westborough.

Replies were made in answer to applications from the following authorities for advice relative to the pollution of ponds, streams, and other bodies of water : —

Bridgewater.
Haverhill.
Hull and Cohasset.
Metropolitan Park Commission.
Palmer.
Plymouth.
Westborough.

Replies were also made during the year in answer to applications from the following authorities and individuals for advice relative to sources of ice supply : —

Boston (Terminal Company).
Concord (George G. Russell and others).
Haverhill.
Holyoke.
Mansfield.
Melrose.
North Adams (three).
Springfield.
Taunton (H. P. Barstow).
Winchester (Charles E. Hemingway).

Rules and regulations for the sanitary protection of sources of water supply were made for the following authorities : —

Water Commissioners of Marlborough.
Water Commissioners of Norwood.
Salem Water Board.

Water Supply.

The following is the substance of the action of the Board during the past year, in reply to applications for advice relative to water supply : —

Acton. An application was received Oct. 27, 1900, from the selectmen of Acton, relative to the quality of the water of a well recently made in that town for public use. The Board replied to this application as follows : —

Nov. 1, 1900.

In response to your communication of October 27, stating that the town of Acton has recently put in a well in the village of West Acton for public use, and requesting the advice of the Board as to the quality of the water, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed. The results of the analyses show that the water has been highly polluted by sewage and not thoroughly purified in its passage through the ground before reaching the well. There are several sources of pollution in the neighborhood of the well, and the circumstances are such that the Board regards the water as unsafe for drinking.

Adams. An application was received July 5, 1900, from the board of health of Adams, for advice relative to the quality of the waters of certain wells and springs in that town which were used for drinking purposes by a considerable number of the inhabitants. The Board replied to this application as follows : —

Oct. 4, 1900.

In response to your request for advice as to the quality of the water of certain springs and wells used as sources of drinking water and domestic

water supply in the town of Adams, the Board has caused the sources indicated by you to be examined by one of its engineers and samples of the water to be analyzed.

The first source examined was an open spring, situated in the westerly part of the village, a short distance west of Forest Park Avenue and south of West Street, which is used for drinking by several families living in the neighborhood of Forest Park Avenue. The results of a chemical analysis of a sample of water sent in by you from this spring show that, while the water has probably at some time been slightly polluted by sewage, it has subsequently been well purified in its passage through the ground, and at the time the sample was collected was of good quality, with the exception of the hardness, which was much greater than that of the regular sources of supply of the town. If the spring should be covered and protected from danger of pollution in this way it would probably furnish a water which would be safe for drinking, though on account of its hardness it is not a desirable drinking water.

The Board would advise that, if it is deemed desirable to continue the use of this source, suitable provision should be made for protecting it from pollution. The use of this spring as a source of drinking water supply should be discontinued if further building should take place on lands in the neighborhood of the spring, and at a higher level.

The next source examined was a spring in Linden Street, which forms, apparently, the only source of water supply for three tenement blocks on Linden Street, containing at the present time about eleven families. The water of this spring shows evidence of considerable pollution by sewage, and its hardness is so great that it is objectionable for many uses. While the water of this spring as it comes from the ground may not be unsafe for drinking, it is not a desirable drinking water, and the Board would advise that water for the supply of these houses be taken from the public system and the use of water of the spring be discontinued.

The remaining sources examined were the wells from which water is drawn for the supply of the operatives at the Renfrew Manufacturing Company's works. The wells are in two groups, one, which has been in use for many years, being located beneath the weaving room of the factory, and the other, which has been recently constructed, being located beneath the floor of that portion of the factory known as the new bleaching plant. The former wells, which it appears have been in use for about fifteen years, furnish a water which is clear, odorless, practically colorless and nearly free from organic matter, and is objectionable only on account of its hardness. The new wells furnish a much harder water than the old wells, and one which has also been at some time considerably polluted by sewage, though subsequently well purified in its passage through the ground.

The Board considers it important to avoid the use of the very hard waters, so far as practicable, and would advise that all the water to be

used for drinking in this factory should be supplied from the old wells, and the use of the water of the new wells for drinking be avoided.

Attleborough (S. O. Bigney & Co.). An application was received from S. O. Bigney & Co. of Attleborough, Jan. 18, 1900, relative to the quality of the water of a certain well which it was proposed to use for drinking purposes. The Board replied to this application as follows: —

July 5, 1900.

In response to your request for advice as to the quality of the water of a well located in your factory and close to the Ten Mile River, which you propose to use as a source of drinking water supply for the factory, the Board has caused the well and its surroundings to be examined by its engineer and several samples of the water to be analyzed.

The analyses of the water show that it is of good appearance, being generally clear, odorless and nearly colorless; but it is quite hard, and has evidently at some time been polluted by sewage and not completely purified in its subsequent passage through the ground. The well is located within a few feet of the Ten Mile River, a stream which receives much direct sewage pollution, and there is also a large population in the region about the well.

Under these conditions, the Board does not consider this well a safe source of drinking water supply, and would advise that the use of the water for drinking be prevented.

Ayer. The water board of Ayer applied to the State Board of Health, March 7, 1900, for advice relative to the "best practicable plan and method of obtaining an additional supply of water for the town." The Board replied to this application as follows: —

May 4, 1900.

The State Board of Health received from you, on March 8, 1900, an application for advice as to the best place and method of obtaining an additional water supply for the town of Ayer, and has caused the surroundings of your present source and other sources in the neighborhood to be examined by one of its engineers.

It is evident from information furnished by you that the yield of your present well is inadequate for the supply of the town of Ayer in a dry season, and that an additional water supply is necessary. A general examination of the region about your present well indicates that the soil in the territory easterly from your present well and about the shores of Sandy Pond is coarse and porous, and the conditions appear to be favorable for obtaining a large supply of water from the ground in this region. The

Board would advise that you make investigations at the most favorable places in this territory, by means of tubular test wells, to determine the character of the soil and the probable quantity of water that can be obtained from the ground. Among the places at which the investigations of the Board indicate that it is especially desirable to make tests is the valley of a small brook easterly from your present well and close to the southerly side of the Fitchburg Railroad, near the point at which the pond approaches the northerly side of the railroad.

These tests should be made with the advice of an engineer of experience in matters relating to ground water supplies; and the Board will assist you by making such analyses of water as may be necessary, and will give you further advice in the matter when you have the results of investigations to present.

The water of your present supply is clear, colorless and odorless, and otherwise of good quality for the purposes of a public water supply as it comes from the ground; but it deteriorates upon exposure to light in the open reservoir, and is objectionable at times on account of a disagreeable taste and odor. Trouble of this sort can be avoided by covering the reservoir or providing a covered tank, so that the water may not be exposed to light from the time it is drawn from the ground until it is delivered to consumers.

Another application was received, May 17, 1900, from the Ayer water board, for advice in regard to a proposed additional water supply, to be taken from the ground north and east of the present well. The Board replied to this application as follows: —

Aug. 2, 1900.

The State Board of Health has considered your further application for advice with reference to an additional water supply for the town of Ayer. It appears that since your last application was made you have made tests of the ground by means of wells northerly and easterly from your present well; but the areas of porous soil in the region in which the tests were made are limited in extent, and ledge was encountered quite close to the surface at several places. Analyses of samples of water from one of the test wells, where the conditions appeared to be more favorable for obtaining a considerable additional supply of water than at any other place where tests were made, showed that the water was affected by the presence of an excessive quantity of iron, which would render it unsatisfactory for many domestic uses.

The tests as a whole do not indicate that it is practicable to obtain a suitable additional water supply for Ayer from the region in the immediate neighborhood of your present well; and the Board would again advise that

you have the subject of additional water supply investigated by an engineer of experience in such matters, with a view to securing a sufficient supply of good water to meet the requirements of the town for a considerable time in the future.

The Board will continue to assist you by making such analyses of water as may be necessary, and will again advise you with reference to the matter when you present the results of further investigations.

Beverly. An application was received from Dr. J. M. Jackson of Beverly Farms, Aug. 14, 1900, for advice relative to the use of the water of Gravel Pond for drinking purposes. The Board replied to this application as follows: —

Nov. 1, 1900.

In accordance with your request of August 13 for advice as to the suitability of the water of Gravel Pond for use for drinking the State Board of Health has caused the pond and its surroundings to be examined and a sample of the water to be analyzed. The results of the analysis, when compared with analyses of the water of Wenham Lake made at about the same time, show that the quantity of organic matter present in the water of Gravel Pond is somewhat less than that in the water of Wenham Lake, the larger quantity of the latter source being doubtless due to the discharge of water from the swampy water-shed of Longham reservoir into the lake. In other respects the waters are not very different in quality and the conditions affecting each source are similar; but provision has already been made by the city of Salem for rules and regulations to protect the water from pollution, and similar protection is necessary for Gravel Pond in case it is to be used as a source of public water supply.

It is understood that you do not intend to construct works for delivering this water, but to distribute it from carts; and, considering the circumstances, the Board is of the opinion that no considerable advantage would be obtained by the use of water in the manner proposed sufficient to warrant the necessary expenditure and care that will be required in the proper collection and delivery of water from Gravel Pond.

Beverly. The water commissioners of Beverly applied to the Board for advice relative to the effect of the use of lead service pipes upon the quality of the public water supply. The Board replied to this application as follows: —

Dec. 6, 1900.

In response to your request for advice as to the effect of the use of lead service pipes upon the quality of the water of the public water supply, the Board has caused samples of the water which has passed through lead or lead-lined service pipes in Beverly to be analyzed, and finds that in all cases

where the water passes through such pipes it takes up lead. The quantities found in all of the samples examined were less than the smallest quantity which has thus far been regarded as injurious to health, though the quantity found in one of the samples approached very closely to this limit.

The results of the investigation as a whole do not show that the use of lead or lead-lined service pipes, with the water of your present supply in its present condition, would be injurious to health; but it is possible that in the future some change may occur in the character of the water which would cause it to attack the lead pipe to a greater extent than at present, or a supply of water may be introduced from some new source which might have a more decided action on lead pipe than the water of your present source now has. Under the circumstances, it is advisable, in the opinion of the Board, to avoid the use of lead for mains or service pipes, unless the pipe is lined in such a way that the lead will not come in contact with the water.

Blackstone. An application was received from the water supply committee of the town of Blackstone, Feb. 6, 1900, for the advice of the Board relative to a proposed water supply for the town, to be taken from the public water works of Woonsocket, R. I. The Board replied to this application as follows: —

March 2, 1900.

The State Board of Health received from you on Feb. 6, 1900, an application for advice with reference to a proposed water supply for Blackstone, in which you state that the board of water commissioners of the city of Woonsocket, R. I., have agreed to lay a ten-inch main pipe to the town line, and furnish water to the town of Blackstone by meter at a minimum rate of 8 cents per 1,000 gallons, if the quantity used amounts to 20,000 gallons or more per day; and you request advice of the Board as to the quality of the water and the desirability of accepting this proposition.

The Board has caused the sources of water supply of the city of Woonsocket to be examined by one of its engineers and samples of the water to be analyzed. From this examination it appears that the water-sheds from which the supply is derived are sparsely inhabited and the water is not at present exposed to serious danger of pollution by sewage, and the quantity of water which the works will yield is probably sufficient for the supply of Blackstone in addition to Woonsocket for several years. The results of the analyses of samples of water from the Woonsocket works show that it is somewhat highly colored, owing to contact with organic matter in swamps and in a shallow storage reservoir not prepared for the storage of water by the removal of the soil and organic matter, and the indications are that it would be objectionable at times on account of the presence of an excessive quantity of organic matter.

The water would be far less satisfactory than a good ground water, and the results of investigations made by the Board with reference to an independent water supply for Blackstone indicate that a supply of excellent ground water, sufficient for the requirements of both of the principal villages of Blackstone for all purposes, can be obtained near Millville, at an expense that would probably be considerably less than the cost of supplying the town by the plan now proposed.

There are other obvious disadvantages to the plan of supplying Blackstone with water from Woonsocket, and, considering the circumstances, the Board does not advise the town of Blackstone to obtain a supply of water from the Woonsocket works.

Boston (penal institutions). An application was received from the commissioner of penal institutions of Boston, Feb. 16, 1900, requesting the Board to examine the water of a new well, driven upon Deer Island, with reference to the propriety of using it as a supply for the institution. The Board replied to this application as follows: —

March 6, 1900.

In response to your request of Feb. 15, 1900, for an examination of the quality of the water of a tubular well recently driven near the buildings of the institution at Deer Island, and not far from the shore of the harbor, and for advice as to the use of the well as a source of water supply for the institution at that place, the Board has caused the location of the well to be examined by its engineer and samples of the water to be analyzed.

At the time the examination of the source was made, the water had an offensive odor as it came from the well, but the odor disappeared from a sample of the water before reaching the laboratory. The analyses show that the water is so excessively hard that it would be liable to injure the health of those to whom it might be supplied for drinking, and it would also be objectionable for many uses on account of the presence of an excessive amount of iron. The quality of the water is not likely to improve with continued use of the source, but, on the other hand, it is more likely to deteriorate, and, owing to the nearness of the well to the sea, the water may become affected by the presence of salt water.

The Board does not consider that this well is a suitable source from which to take water for drinking or cooking.

Dartmouth (Bay View). An application was received from Franklyn Howland, Jan. 6, 1900, for the advice of the Board with reference to an additional water supply for a summer settlement at Bay View in Dartmouth. The Board replied to this application as follows: —

FEB. 5, 1900.

The State Board of Health received from you, on Jan. 6, 1900, an application for advice with reference to obtaining an additional supply of water for the summer settlement of Bay View, by increasing the capacity of the well from which the present supply is drawn, and as to whether the water from this source will ever become contaminated. You also request advice as to the probable quantity of water that may be obtained by deepening the well from which the present supply is drawn, and the probable quality of water that the source will then yield. Regarding the location and capacity of the present source, you have furnished the following information: —

The well is at a summer resort, and is on the highest point of a ridge which runs parallel with the bay shore. Surface at well is 1,000 feet from and 40 feet above high-water mark. Probably only three cottages will ever be built on land as high as at the well. There will never be but one cesspool within 125 feet of the well, and that one not nearer than 50 feet. All but three cesspools that will ever be built will be where the surface is lower than at the well, and continues to descend. Cesspools used but two or three months in a year.

Well 30 feet deep; through a layer of earth, then a thick layer of rock, then a few inches of clay or marl to bed rock. No water came till bed rock was reached, when it came up through a crack in it. Well 2 feet in diameter. Last summer the inflow was so slow and the storage capacity of the well so small that we failed to get a full supply for the nine cottages attached to the main, by the use of windmill.

Regarding the quality of the water of your present source, the Board expressed the opinion last year, that, while the water had been at some time polluted, the indications were that under the existing conditions it was suitable for drinking and other domestic uses. The location of cesspools so close to the well, as is indicated in your communication, is a great menace to the purity of the water.

The Board has considered the available information as to the probable yield of the present well, and is of the opinion that no material addition can be secured by any increase that it is practicable to make in the area of the bottom of the well.

It is probable that the supply can be increased by sinking a tubular well in the bottom of the present well as proposed, but this is uncertain. If there are many seams in the rock through which water passes, and one or more of such seams should be tapped by the proposed well, a considerable increase in the supply might be secured, but otherwise but little increase in the supply could be obtained.

Moreover, if a considerable increase in the yield of the well should be obtained by sinking a well through the rock in its bottom, its quality would probably be no better than that of the present well, and might not be as good. Considering all the circumstances, the Board is of the opinion that

it is not advisable to attempt to increase the supply of water from your well in the manner proposed.

The Board would advise that you make an examination to see whether a well cannot be located at some place in the neighborhood where a greater area of land will drain toward it than in the case of the present well, and that a location be selected where the water is not likely to be affected by drainage from cesspools. When you have selected a location which seems likely to furnish a satisfactory supply, the Board will advise you concerning it, if you so request.

Dracut (American Woolen Company). An application was received from the American Woolen Company, Dec. 11, 1899, for advice relative to a proposed water supply for use in the mill and dwelling-houses of the company in Collinsville (Dracut). The Board replied to this application as follows: —

Feb. 5, 1900.

The State Board of Health has considered your application for advice with reference to a proposed water supply for your mill and several dwelling-houses in the village of Collinsville, which it is proposed to obtain from tubular wells in the valley of Double Brook in Dracut, and has caused the locality to be examined by one of its engineers and samples of water from test wells in this region to be analyzed.

The first test wells examined were located near the brook, close to the village; but the results of analyses showed that the water of these wells was considerably polluted by sewage discharged upon or into the ground in the village, and further tests were then made in a meadow further up stream and near the outlet of Long Pond. Analyses of samples of water from the test wells at the last location show that it is soft, nearly colorless and free from odor, and is otherwise of good quality for the purposes of a public water supply. Whether the water will remain satisfactory when the quantity required for the supply of Collinsville is drawn continuously from wells at this place, cannot be predicted with certainty. The meadow in which the wells are located contains a considerable depth of peaty soil and is subject to flooding at times of high water in the brook, and water drawn from wells in similar locations has in some cases deteriorated after a longer or shorter period of use and become objectionable on account of an excess of iron. The chances of deterioration in this case can apparently be materially lessened by draining the meadow so that water will not stand upon it for a very considerable time, and it appears to be feasible to provide drainage at no great expense. The wells yielded water freely when pumping with a hand pump, and the indications are that a sufficient quantity of water for the requirements of the factory and houses in the village at all times can be obtained from the ground in this region.

A supply of pure water for drinking and other domestic uses is greatly needed in the village at the present time; and, considering all the circumstances, the Board would advise the construction of works without delay for supplying the village with water from the ground in the region in which the test wells are located, near the outlet of Long Pond.

GLOUCESTER. An application was received from the water commissioners of Gloucester, Dec. 29, 1899, for the advice of the Board in regard to a proposed increase of the public water supply by taking the water of Haskell's Brook in West Gloucester and of Chebacco Lake in Essex. The Board replied to this application as follows: —

FEB. 3, 1900.

The State Board of Health received from you, on Dec. 29, 1899, an application for advice with reference to a proposed additional water supply for the city of Gloucester, in which you present the following outline of your proposed plans: —

It is proposed to add the waters of Haskell's Brook in West Gloucester, Ward 8 of the city, to the present sources of supply, and, as soon as practicable, purify and improve these present sources, consisting of the Dike's and Wallace reservoirs, by the removal of vegetable deposits, stumps, etc., from the basins, the construction of gate-houses with screening arrangements, etc., as outlined in the report of our engineer submitted to you herewith.

When a further supply of water is needed, it is proposed to obtain it from the Chebacco Lakes, using the Haskell's Brook storage reservoir as a receiving basin for this Chebacco water, which, however, may be pumped directly into the Bond's Hill distributing reservoir, if desired.

The application was accompanied by a report by your engineer, Mr. Percy M. Blake, relative to the proposed plans, from which it appears that one of the features of the plan for increasing the water supply is to raise the dam and increase the storage capacity of Wallace reservoir.

The Board has caused your present sources and proposed new source of supply to be examined by its engineer, and has carefully considered the information submitted and the results of the numerous analyses that have been made of the various sources of water supply in the neighborhood of Gloucester. A comparison of the estimated probable yield of your present sources of supply with the records of the quantity of water used by the city indicates that the present use of water is in excess of the capacity of your present works, and an additional supply of water is evidently necessary.

The results of analyses of several samples of water collected from Haskell's Brook at the site of the proposed dam at the outlet of the present mill pond on the brook have shown that it is highly colored, and contains

a very large quantity of organic matter in the summer season. Samples collected at other seasons, when a large quantity of water was flowing through the pond, were found to be of much better quality, and the color and quantity of organic matter present were not excessive. It seems probable that the poor condition of the water at times of low flow is largely due to contact with stumps and organic matter in the bottom of the present shallow pond; and the indications are, that if the water flowing from this water-shed should be stored in a reservoir properly prepared for the purpose by the removal of all stumps and other organic matter, its quality would improve instead of deteriorating; and by draining any swamps on the water-shed in which water is likely to remain for a considerable time, so that the water from the water-shed will flow quickly into the reservoir, it is probable that a water of good quality, which will have but little color, can be obtained from the proposed reservoir at all times.

The quality of the water of your present sources of supply is objectionable on account of its color and the presence of considerable quantities of organic matter, which impart to the water at times a disagreeable taste and odor. By removing the stumps and the other organic matters from the bottoms of these reservoirs, a great improvement can be made in the quality of the water of these sources. The quality of the water can probably be further improved by draining the swamps within the water-sheds, so as to prevent water from standing upon them.

By constructing a reservoir on Haskell's Brook and raising the dam of the present reservoir on Wallace Brook, as proposed, the quantity of water which your sources of supply will furnish can be increased to about one and one-half times their present yield, and will be sufficient to supply the city for several years in the future, unless the use of water or the growth of the city should become much greater than it seems at present reasonable to expect. Increasing the capacity of Wallace Pond will make that source capable of storing a greater proportion of the water which it receives from its own water-shed and the contiguous water-shed of Fernwood Lake, and will also have a tendency to improve the quality of the water by increasing the depth of the reservoir.

The proposed plan of constructing a storage reservoir on Haskell's Brook and raising the dam of Wallace Pond is, in the opinion of the Board, an appropriate method of increasing the water supply of Gloucester; and, if the proposed new reservoir and the present reservoirs are properly prepared for the storage of water, and such drainage of swamps within their water-sheds as may be found desirable is provided, the Board is of the opinion that the sources will furnish a water of much better quality than that at present supplied to the city.

The water board of Gloucester made the following application to the State Board of Health, June 26, 1900: —

The city of Gloucester desires your advice as to the practicability and expediency of filtering the water of Lily Pond Brook as a means of obtaining a supplementary supply of water; and by this plan have in view the improving of the water in Wallace and Dike's Meadow basins.

The Board replied to this application as follows: —

AUG. 2, 1900.

In response to the application, the Board has caused the proposed source of supply to be examined by its engineer and has examined the results of numerous analyses of samples of the water collected at the outlet of Lily Pond, a reservoir on Lily Pond Brook, at various seasons of the year.

In a communication from this Board in February last, in response to an application from your board for advice relative to a proposed additional water supply for Gloucester, you were advised that the consumption of water by the city was at that time in excess of the probable yield of your present sources of supply in a series of dry years, so that an additional supply was evidently necessary.

Judging from the information available to the Board, the additional quantity of water that Lily Pond Brook would furnish, even assuming that the storage in Lily Pond would be utilized to its fullest capacity, would not be likely to increase the yield of your sources of supply materially beyond the quantity of water used at present, and a further additional supply would be necessary in a very short time.

Lily Pond is a very shallow reservoir, and over the greater portion of its area, bushes, plants and grasses of various kinds grow above the surface of the water. Analyses of the water show that it is very highly colored, and contains nearly always an excessive quantity of organic matter. To improve the quality of this water by filtration and render it satisfactory for drinking and other domestic uses would be a difficult and expensive operation; and, before undertaking the construction of works for this purpose, it would be very important to make suitable experiments, in order to obtain the necessary information as to the best method of improving this water and the cost of constructing and operating the necessary works.

There are only two ways by which the quality of the water of Wallace and Dike's Meadow basins can be improved, — one by drawing the reservoirs off and properly preparing their bottoms for the storage of water, and the other by filtration. By the plan under consideration it would not be practicable to draw off either of the present storage reservoirs, to make such repairs and improvements as are necessary, without exposing the city to the danger of an exhaustion of its water supply. It would not, therefore, be possible to improve materially the water in Wallace and Dike's Meadow basins, as suggested in your application, and the only way of improving these waters under this plan would be by filtration. The taking of Lily Pond and the construction of works for filtering the water supplied

to the city would require a large outlay; and, since this plan would not, in the opinion of the Board, provide an adequate supply of water for the city beyond a very limited time, and a further outlay would soon be necessary for an additional supply, the Board does not advise its adoption.

The plan presented by you last winter, concerning which you were advised by the Board on February 3 last, provided for the construction of a large storage reservoir and for improvements in the present reservoirs, and the Board advised you at that time as follows: —

> The proposed plan of constructing a storage reservoir on Haskell's Brook and raising the dam of Wallace Pond is, in the opinion of the Board, an appropriate method of increasing the water supply of Gloucester; and, if the proposed new reservoir and the present reservoirs are properly prepared for the storage of water, and such drainage of swamps within their water-sheds as may be found desirable is provided, the Board is of the opinion that the sources will furnish a water of much better quality than that at present supplied to the city.

With the conditions now existing, the Board is unable to give you any better advice than this, and would advise that steps be taken without delay to provide an adequate additional supply of water for the city of Gloucester, in view of the present danger of a shortage of water.

Grafton. An application was received from the Grafton Water Company, Sept. 7, 1900, relative to the propriety of taking a temporary supply of water from Lake Quinsigamond, in case of a shortage of water in the existing supply of the company. The Board replied to this application as follows: —

Oct. 4, 1900.

The State Board of Health received from you, on Sept. 7, 1900, a communication stating that the sources used for the supply of water to the town of Grafton were liable to become inadequate at any time, and requesting the advice of the Board as to the propriety of obtaining a temporary additional supply of water from the Quinsigamond River by utilizing the fire pumps in the factory of Finlayson, Bousfield & Co. at North Grafton. It appears also that an additional water supply for the town has sometimes been obtained from the spring known as Nelson's Spring, located near this factory.

The Board has caused your present sources of supply and the proposed source of additional supply to be examined by one of its engineers, and samples of the water from the sources which have hitherto been used for the supply of the town and from the proposed new source to be analyzed.

The water of your present sources of supply, which are located near the Quinsigamond River at the foot of the slope upon which the main village of Grafton is situated, is quite hard and shows evidence that it has been considerably polluted by sewage, though it has subsequently been well

purified in its passage through the ground; but it is desirable, in selecting a source of additional supply, that a sufficient quantity of good water be secured, if possible, for the supply of the town at all times, in order that the use of water from the present sources may be avoided.

By the plan which you now present for obtaining an additional water supply the water would be drawn from the Quinsigamond River at North Grafton. The place at which the water would be drawn from the river is so located that, when the factory is in operation, the supply would come from the raceway after the water has passed through the factory; but when the factory is not in operation, the water would come from the main river below the dam. In either case, an examination of the surroundings shows that the water would be taken immediately below points at which sewage is discharged into the stream, and would also be subject to pollution by manufacturing wastes from the factory. Under the circumstances, a supply obtained from this place, as proposed, would greatly endanger the health of those who might use the water for drinking, and the Board does not advise the adoption of this plan for securing an additional water supply for Grafton.

If water should be taken from Flint's Pond, above the factory, the danger from sewage pollution would be somewhat lessened; but it is evident that much sewage finds its way into Lake Quinsigamond, and would thence find its way into the source of supply.

A chemical analysis of the water from Nelson's Spring shows that it has at some time been highly polluted by sewage, and, though at the time the sample was collected the water had been well purified in its passage through the ground, this spring is not a desirable source of water supply.

A supply of good water sufficient for the needs of the town of Grafton at all times is urgently needed; and the Board would advise that you cause a further investigation to be made as soon as possible, with the assistance of an engineer of experience in matters relating to water supply, with a view to securing a source of ground water supply from some unpopulated territory that will furnish a sufficient quantity of water to meet the needs of the town at all times.

The Board will assist you in any further investigations that you may make, by analyzing such samples of water as may be necessary, and will give you further advice in the matter, when you have the results of further investigations to present.

Hardwick (Gilbertville). An application was received from the George H. Gilbert Manufacturing Company, April 12, 1900, for advice relative to the best method of protecting a proposed system of water supply from pollution. The Board replied to this application as follows: —

JUNE 8, 1900.

The State Board of Health received from you, on April 12, 1900, an application giving notice of your intention to increase your system of water supply in the village of Gilbertville in Hardwick, and requesting the advice of this Board as to the best practicable method of assuring the purity thereof.

It appears that the company proposes to acquire the right to the use of a stream of water flowing from the hills southeast of the village, in order to increase the water supply to the village, and that you especially desire to be advised as to how much land it would be necessary to acquire about the brook, to secure the water from pollution. It appears that you do not propose to take water directly from the brook, but to take it only from the ground by means of a well or filter-gallery to be located in the neighborhood of the brook.

The Board has considered your application, and has caused the stream and its water-shed to be examined by one of its engineers. The only serious danger of pollution to which the brook appears to be exposed at the present time is from cattle pastured within its water-shed; but if the water should be taken from the ground, as proposed, it is not likely, in the opinion of the Board, that the pollution of the brook would noticeably affect the character of the ground water, if the well or other works from which the ground water is to be taken should be located as much as 50 feet from the brook. It is important that the well or any other source from which ground water is taken should be tightly covered, so as to prevent the entrance of animals and exclude sunlight, and that the company control all the land within 100 feet of any well or other collecting works, and prevent its use in any manner that would tend to pollute the water.

The Board is informed that the brook dries up in summer, and it seems doubtful whether any considerable supply of water can be obtained from the ground in this neighborhood, unless coarse and porous soil of considerable depth and extent is found, in which the well or other collecting works can be located.

HAVERHILL. An application was received, July 25, 1900, from the mayor of Haverhill, for the advice of the Board relative to the protection of the water-shed of Kenoza Lake, the substance of the application, together with the advice of the Board, being contained in the following communication: —

SEPT. 6, 1900.

The State Board of Health received from you, on July 25, 1900, a communication requesting the advice of the Board, in behalf of a committee of the board of aldermen and the board of water commissioners of Haverhill, as to whether the construction of house sewers within the water-sheds of Kenoza Lake and Round Pond, in accordance with a plan submitted to this Board last year, together with the construction of a storm-water sewer

in Kenoza Avenue, as mentioned in the report accompanying the said sewer plans, will afford sufficient protection of the purity of the water of Kenoza Lake, even when the density of population on its water-shed shall be greatly increased; or whether there would still remain a danger of pollution, which might be obviated by removing the buildings, and which would be sufficiently great to warrant the expenditure of a larger sum of money in acquiring possession of the water-shed.

The Board has caused the locality to be examined by its engineer, and has considered the plans for the sewerage of this district and other information which has been submitted by the city authorities.

Kenoza Lake, including the East Meadow River source, the water of which is supplied through Kenoza Lake, is now the principal source of water supply of the city; and, with Round Pond and Crystal Lake, this source seems likely to be capable of supplying the portion of the city north of the Merrimack River for possibly the next twenty years. After that time, changes in the sources of supply or other circumstances may possibly cause the abandonment of the Kenoza source.

It appears that the city of Haverhill now owns or controls all of the land bordering upon the shores of the lake, and extending for a long distance back from the shores. By providing a system of sewers and a system of storm-water drains for removing all of the sewage and storm water from the district around the westerly end of Kenoza Lake, all sewage and polluting matters which might be deposited upon the ground within its water-shed can be kept out of the lake, though by this plan the area of its water-shed would be considerably reduced. In the opinion of the Board, considering the large area of land now controlled by the city all about the lake, which will in the future be kept free from population, an efficient system of sewers and storm-water drains in the portion of its drainage area under consideration can be made to furnish a sufficient protection of the purity of this source, even if the territory should become densely populated.

There would still be some danger that, through lack of proper provision for removing the sewage and rainfall, or through lack of care in the construction and operation of the sewers or drains, or through some unforeseen circumstance, polluted water from this water-shed might find its way into the lake, if the territory should be allowed to become densely populated. There is no doubt but that keeping the lands free from population will be a sure means of preventing all danger of pollution of the lake in the future.

With these conditions, the choice of a plan for protecting the purity of the water of the lake depends largely on the comparative cost of the two plans; and it is apparent that the cost of providing systems of sewerage and drainage is likely to be much less than the cost of taking control of all of the lands.

Whatever plan may be adopted, it is important that it be carried out as soon as possible, to prevent the further pollution of the lake from the houses on its water-shed. It will also be important to provide at the same time for the protection of the water-shed of Round Pond, if that source is to be retained as a source of water supply for Haverhill.

HAVERHILL. An application was received, May 9, 1900, from the water commissioners of Haverhill, for advice relative to the location of a new pumping station at Kenoza Lake. The Board replied to this application as follows: —

JUNE 8, 1900.

The State Board of Health has considered your application for advice with reference to the location of a new pumping station for the Haverhill water works on the northerly side of Kenoza Lake, and has caused the locality to be examined by one of its engineers.

The location of the pumping station and intake to your water works at the westerly end of the lake is objectionable under present conditions, on account of the large population in this portion of the water-shed, which is not provided with a satisfactory means of sewage disposal. It is not desirable, on the other hand, to move the intake very far toward the easterly end of the lake, since it is important that the somewhat highly colored water from Millvale reservoir, which enters that end of the lake, should be stored for a considerable time in the lake before reaching the intake.

Considering the circumstances, the location proposed by you for the pumping station and intake is, in the opinion of the Board, as satisfactory as any that it is practicable to select.

HAVERHILL. An application was received, May 3, 1900, from the superintendent of parks of Haverhill, for the advice of the Board relative to the purity of certain waters in Winnekeni Park, which are used for drinking purposes. The Board replied to this application as follows: —

JUNE 8, 1900.

In response to your application for advice as to the quality of the water of a spring and well in Winnekeni Park, which is used largely by the public for drinking, the Board has caused the sources referred to to be examined by one of its engineers and samples of the water to be analyzed. The examination shows that there are no buildings in the neighborhood of the spring, and this source does not appear to be exposed to any danger of sewage pollution. The analysis shows that the water is soft and otherwise of good quality, and suitable for drinking.

The analysis of a sample of water from the well located at the castle in the park shows that some of the water entering the well has been consider-

ably polluted by sewage, and not as completely purified in its passage through the ground as is desirable. The well is situated not far from the house and stable, and it is probable that the pollution of the water of the well comes from the latter building. Judging from the examinations that have been made, there is considerable doubt as to whether the water is at all times safe for drinking; and, considering the circumstances, the Board would advise that the use of this well as a source of drinking water be avoided.

HOLYOKE (the Deane Steam Pump Company). An application was received, April 24, 1900, from the Deane Steam Pump Company of Holyoke, for advice relative to the quality of the water of certain wells for drinking purposes. The Board replied to this application as follows: —

JULY 5, 1900.

The State Board of Health has considered your application for advice with reference to the use for drinking of water from tubular wells located near your factory in the city of Holyoke, and has caused the wells and their surroundings to be examined by one of its engineers and samples of the water to be analyzed. The results of the analyses show that the water in its present state is clear, odorless and colorless, but it has evidently been considerably polluted by sewage and to a high degree purified in its subsequent passage through the ground. The water is also quite hard, while the water of the city supply, which, it appears, is also supplied for use in the factory, is soft.

These analyses do not indicate that the water as supplied by the wells at present is unsafe to use for drinking purposes, but its great hardness is objectionable, and changes in the height of ground water and in the circumstances attending its pollution may at any time render it unsafe; hence the Board cannot recommend its continued use for drinking purposes.

HYDE PARK. The board of health of Hyde Park applied to the State Board of Health, Dec. 14, 1899, requesting information relative to the quality of the water furnished by the recent additions to the works of the Hyde Park Water Company, to which the State Board of Health replied as follows: —

MARCH 2, 1900.

The State Board of Health received from you, on Dec. 15, 1899, a communication stating that water from tubular wells at Four Corners, so called, in the westerly part of the town near Dedham, and in close proximity to Mother Brook, was being pumped into the mains of the Hyde Park Water Company, and requesting that an examination of the water be made and

a report of its condition be furnished your board. It was suggested at the same time that a pumping test of the wells was to be begun on December 18 and to continue for six days, and that an examination made at that time might furnish information as to the quality of the water. You also request that the supply from the old source be examined and its condition reported to you.

In response to your request, the Board caused the locality of the tubular wells at Four Corners to be examined, and samples of the water pumped from the wells, during the pumping test referred to, to be collected and analyzed. The results of the analyses of eleven samples, collected between Dec. 18 and 28, 1899, showed that the water was nearly colorless and odorless, and that the quantity of organic matter present was insignificant. The quantity of chlorine present in the water of these samples was considerably greater than is found in unpolluted waters in this region, and the excess of chlorine above the normal for the region, considered in connection with the large quantity of nitrates and other mineral matters, indicates that the water has at some time been polluted by sewage; but during this test the water had become thoroughly purified before reaching the wells, and in the opinion of the Board this water in its present state is better than the water now supplied by the Hyde Park Water Company, and is suitable for drinking and other purposes of a public water supply.

Whether the water will deteriorate when drawn continuously from the ground at this place, cannot be predicted definitely. The wells are located quite close to Mother Brook, a stream which receives considerable pollution; and it seems probable that, if a large yield of water is obtained from these wells, a considerable portion of it will be derived from Mother Brook by filtration through the ground. Wells in similar situations have in some cases deteriorated after a longer or shorter period of use, as experience with present sources has already shown. There also appears to be danger that the water may become affected by the presence of an excess of iron, on account of the large deposit of peaty matter in the meadow in which the wells are located. One of the chief dangers which threatens this supply is the pollution from the population in the neighborhood of the wells. Sewage discharged into the ground in the region about the wells evidently affects the quality of their water, and the population in this region seems likely to grow rapidly and to cause a deterioration in its quality in the future.

Considering the circumstances, if this source is to be used, it is desirable that the water be analyzed frequently, in order that any serious deterioration in its quality may be detected.

You have also requested advice as to the quality of the water supplied from the old sources. Two samples of water have been collected from the old sources during the present year. A sample collected at the pumping station on January 16 shows no improvement in quality as compared with a sample collected at about the same time last year, but, on the other hand,

shows a considerable deterioration as compared with its quality a year ago. A sample collected in February of the present year was also found to be of somewhat poorer quality than a sample collected at about the same time last year. Since it does not appear that an improvement has been effected by any changes that may have been made in the wells from which this water is drawn, but that, on the other hand, the water is of poorer quality than the water pumped from these sources last year, the Board sees no reason to change the opinion expressed in its previous communication regarding the quality of the water of these wells.

Lenox. An application was received from the board of health of Lenox, Nov. 13, 1900, for advice relative to the quality of the water of a well in that town used by a considerable number of people for drinking purposes. The Board replied to this application as follows: —

Dec. 6, 1900.

The State Board of Health has considered your application of November 13, for advice as to the quality of the water of a well used to supply several estates in Lenox, where it is used by a considerable number of people for drinking, and has caused the well and its surroundings to be examined by one of its engineers and a sample of the water to be analyzed. The analysis shows that the water is clear, colorless and odorless, and, while it had at some time been slightly polluted by sewage, it had subsequently been well purified in its passage through the ground before entering the well. The hardness of the water was excessive, being more than three times as great as the average hardness of the water supplied by the Lenox Water Company.

The only important danger of pollution to which the water of the well is now exposed is caused by the presence of a sewage-disposal area upon the edge of the water-shed. At the time the examination by the Board was made, this sewage-disposal area was not purifying the sewage, and the crude sewage was flowing through an overflow from this disposal area upon the surface of the ground, and thence into a small brook which flows in a direction away from the well. Sewage entering the ground at this place, however, is liable to affect the quality of the water of the well.

The Board regards it of importance to health to avoid the use of the very hard waters; and since in this case a much softer water can be obtained from the pipes of the Lenox Water Company, which are laid in this neighborhood, the Board would advise that the use of water from this well for drinking or cooking be discontinued. If the use of this well is to be continued for any purpose where the water may be available for drinking, it is important that no sewage be disposed of within the area from which water may percolate toward the well.

The sewage-disposal area referred to is not purifying the sewage, and the result is the serious pollution of a small brook near by. Provision should be made for the proper disposal of this sewage.

LINCOLN. An application was received, Sept. 21, 1900, from the board of health of Lincoln, for advice relative to the quality of certain waters used in that town for domestic purposes. The Board replied to this application as follows: —

OCT. 4, 1900.

In response to your application of Sept. 21, 1900, the Board has caused a well on land of Julia Bemis and its surroundings to be examined and a sample of the water to be analyzed.

It appears that this well has until recently been extensively used for drinking purposes by families in the neighborhood. The results of the examination show that the water is turbid and colored, has a disagreeable odor and is evidently badly polluted, and, in the opinion of the Board, the water of this well is liable to be very injurious to the health of those who may use it for drinking.

An examination has also been made, as requested, of the distributing reservoir of the Lincoln water works. This reservoir appears to be in satisfactory condition at the present time, and an analysis of a sample of its water indicates that its quality is not materially different from the water of Sandy Pond, from which it is supplied. The sample was found to have a faintly vegetable odor, which is doubtless due to the presence of microscopic organisms commonly found in surface waters. If the water of the source of supply, Sandy Pond, is protected from pollution, there seems to be no reason why it should deteriorate in the distributing reservoir under present conditions.

LOWELL. An application was received, Nov. 24, 1899, from the water board of Lowell, requesting the assistance of the State Board of Health "for the purpose of examining certain sources of water supply, such as Beaver Brook in Collinsville, Forge Village and other places, to determine the quantity and quality of the supply to be obtained." The Board replied to this application as follows: —

JAN. 19, 1900.

The State Board of Health has caused analyses to be made of samples of the water of four test wells which have been driven under your direction in the valley of Beaver Brook, near the boundary between Massachusetts and New Hampshire, with a view to securing an additional water supply for the city which will not injure the health of the inhabitants by dissolving lead from lead service pipes. The four test wells thus far

driven penetrated a stratum of gravel from which water could be pumped with much freedom, and the conditions appear to be favorable for obtaining a large quantity of water from the ground at this place.

The analyses indicated an excellent quality of water in all respects except in the quantity of iron and in the quantity of carbonic acid. The quantity of iron from one well was greater than usually found in the Hydraulic well water; from another well it was a little less than the quantity usually found in the Boulevard well water; and from the two other wells the quantity was so small as to be unobjectionable.

The quantity of carbonic acid present in the water of the wells, to which the action of the water upon lead pipes is chiefly due, was carefully determined, and the results show that in one of the wells the quantity of carbonic acid present was less than the average quantity that has been found in the water of the Boulevard wells during the past year, but the water of the remaining wells contained a considerably greater quantity of carbonic acid than the average quantity found in the water of the Boulevard system. The results of the several analyses are enclosed.

The tests as a whole are somewhat unfavorable with respect to the quantity of carbonic acid present, and indicate that the water might have serious action upon lead pipes. Further and more thorough tests might show a considerably different result from those thus far made; and, considering all the circumstances, the Board would advise that a further test of this source be made by pumping from a group of wells in this region at a rate as great as would be required in the city service, and for a sufficient length of time, perhaps two weeks, to make it possible to determine approximately the probable quality of the water and its probable action upon lead service pipes. The Board will assist you by making the desired analyses during the progress of the experiment.

In a previous communication to your board, on Dec. 29, 1899, the State Board of Health advised you to make further and sufficient tests beyond the upper end of the present Boulevard well system, to determine whether it is practicable to secure in this region a sufficient additional quantity of water to furnish the whole supply that is at present required by Lowell, so that the use of water from the Cook and Hydraulic wells may be avoided, since it appeared that a further supply from the region in which the Boulevard wells are located could probably be introduced in a shorter time and at less expense than from any other source.

The Board would again urge that tests in this region be made without any further delay.

An application was received from the president of the Lowell water board, Sept. 6, 1900, for advice relative to the quality of the water of certain test wells which had been driven upon the Cushing

Farm, Pawtucket Boulevard, and other land in that locality, special information being desired relative to its action upon lead. The Board replied to this application as follows: —

Sept. 13, 1900.

The State Board of Health has considered your application for advice with regard to the quality of the water obtained from the test wells driven on the Cushing Farm, Pawtucket Boulevard, and other lands in that neighborhood, shown on a plan submitted by you, and has caused the locality to be examined and samples of the water to be analyzed.

You especially request that the water be examined and tested as to its action on lead, and state further that you would like the results of the investigations of the Board on or before September 15. Within this time it has not been practicable to make thorough tests as to the probable action of this water upon lead; but a comparison of the results of determinations of the quantity of carbonic acid and oxygen present in the water of these test wells with quantities found by previous tests in the water of the Boulevard wells shows that the water of the test wells in these respects compares favorably with the water of the old Boulevard wells.

In other respects, all of the test wells show a satisfactory quality of water at the present time. One of them, No. 3, shows that the water has been polluted, probably by household wastes, and again purified in passing through the ground. The water of this well is no doubt affected by the wastes from the house on the plain between Wellington and Wyoming streets, which can be prevented if you purchase this property. There is also some evidence that the water of some of the wells has been affected by drainage from the barn on the Cushing property, which, it appears, is not now used, and it is understood will not be used in the future if water is to be taken from the wells in this locality.

Lowell (trustees of the Lowell Hospital Association). An application was received, April 17, 1900, from the trustees of the Lowell Hospital Association, for the advice of the Board relative to the adoption of a Barnstead pure water still for the use of the hospital. The Board replied to this application as follows: —

June 11, 1900.

The State Board of Health has considered your request for advice as to adopting for the Lowell Hospital a Barnstead pure water still, which you state is represented to produce chemically pure, palatable distilled water, and as to whether it is adapted to furnish suitable water for surgical operations and for drinking. The Board has caused one of these stills, in operation at one of the hospitals, to be examined and samples of the distilled water to be analyzed. The results of the chemical analyses show that the dis-

tilled water is not chemically pure, but contains some organic matter and chlorine, indicating that the distillation of the water is not complete. Moreover, bacteria were present in the water after distillation, a further evidence of the defects of the distilling process. Examinations of the water supplied for drinking from this still showed still less satisfactory results.

The Board does not consider that the distilled water from this still as operated in the hospital in which it was examined would be an entirely satisfactory water for surgical operations or for drinking. The Board will, however, make further examinations, in order to determine whether the defects which have been observed belong to the apparatus itself, or are the result of improper management of it.

LUDLOW. An application was received, July 28, 1900, from the Ludlow Manufacturing Company, for the advice of the Board relative to the quality of the water of a new well which had been driven by the company. The Board replied to this application as follows: —

AUG. 10, 1900.

In reply to your communication of July 27, 1900, requesting advice as to the quality of the water of a well which you propose to use as a source of drinking water supply for the operatives in the mills of the Ludlow Manufacturing Company, the State Board of Health has caused the well and its surroundings to be examined by one of its engineers and a sample of the water to be analyzed. The well is located near the densely populated portion of the village, and the analysis shows that some of the water has been polluted by sewage, but subsequently well purified in its passage through the ground.

The water in its present state, while harder than is desirable, is, in the opinion of the Board, safe for drinking; but it is desirable that the water be analyzed from time to time, to determine whether any deterioration is likely to take place when the water is in continual use.

MASSACHUSETTS REFORMATORY (Concord). The superintendent of the Massachusetts Reformatory applied to the State Board of Health, May 3, 1900, for advice in relation to certain sources proposed as water supplies for the reformatory. The Board replied to this application as follows: —

JUNE 11, 1900.

In response to your application for advice as to the quality of the water of certain tubular wells in the neighborhood of the reformatory and of the water of Nashoba Brook for use for drinking and other purposes in the reformatory, the Board has caused these sources and their surroundings

to be examined by one of its engineers and samples of the water to be analyzed.

One test well is located east of the reformatory and close to the sewage-disposal area of the institution, and would be an unsafe source of water supply. Two test wells, located about 1,000 feet west of the reformatory and about 500 feet from Warner's Pond, penetrated coarse material and the conditions appear to be favorable for obtaining a large amount of water from the ground in this neighborhood; but the results of analyses of samples of water from these wells show that it contains so large a quantity of iron as to render it objectionable for nearly all domestic uses, and the Board does not advise the introduction of water from wells in this location for the supply of the reformatory.

The conditions appear to be favorable for obtaining water freely from the ground at other places not far from the one in which your last test was made, and it is advisable, in the opinion of the Board, to make further investigations in this region.

The sample of water from Nashoba Brook was found to be highly colored and to contain a large quantity of organic matter. The brook is exposed to pollution from a large population on its water-shed, and the water of this source would, in the opinion of the Board, be unsafe for drinking and objectionable for many other uses.

Newton (Woodland Park Hotel, Auburndale). An application was received, Aug. 11, 1900, from the proprietor of the Woodland Park Hotel, for advice relative to the quality of the water of a tubular well recently driven on the premises of the hotel. The Board replied to this application as follows: —

Oct. 4, 1900.

In response to your request of August 10, for advice as to the quality of the water of a tubular well on the premises of the Woodland Park Hotel in Auburndale, which it is intended to use as a source of drinking water supply, the Board has caused the well and its surroundings to be examined and samples of the water to be analyzed. The analyses show the water to be clear, colorless and odorless, but it is very hard, and has at some time been highly polluted by sewage and not thoroughly purified in its subsequent passage through the ground to the well.

The Board cannot, therefore, recommend this well as a source of water supply for drinking or domestic purposes.

Northampton. An application was received, October 5, from the water board of Northampton, for advice relative to a proposed additional water supply for that city. The Board replied to this application as follows: —

Dec. 6, 1900.

The State Board of Health received from you, on Oct. 5, 1900, an application giving notice of your intention to introduce an additional system of water supply in the city of Northampton, and submitting a description of the proposed sources and works. The description states that it is proposed to take water by gravity from West Brook and its tributaries in the town of Whately, with an intake basin near the northerly end of West Whately Street, so called, and a storage reservoir in the future about 2,000 feet above the intake basin. Two plans of conveying the water from the intake basin to the city are suggested, one by laying a pipe directly to the present mains in the village of Leeds, and the other by conveying the water in a pipe to the head waters of Beaver Brook and allowing it to flow in the brook to a storage reservoir to be formed by a dam near Mountain Street in Williamsburg, and conveying it thence by a pipe to the present mains in Leeds.

The application is accompanied by a report of your engineer, in which the latter plan is recommended, and by a general plan of the proposed reservoir on Beaver Brook. Information has also been submitted relative to the cost of the proposed works, and other information has been furnished relating to the flow of various streams in the neighborhood of Northampton.

The Board has carefully considered your plans, and has caused the proposed source and others in the neighborhood of Northampton to be examined by its engineer and samples of the various waters to be analyzed. The Board is informed that Roberts' Meadow Brook, your present source of supply, proved inadequate for the supply of the city during the drier part of the present year, and, the reservoirs becoming practically empty, a temporary additional supply was introduced from Mill River at Leeds. While the flow of Roberts' Meadow Brook has occasionally been measured, it does not appear that any continuous records of the yield have been kept, or that any measurements of the present consumption of water in the city have been made; but, judging from such estimates of the probable flow of the stream as can be obtained by comparison with the flow of other streams, it seems probable that the consumption of water in Northampton is considerably greater in proportion to the population than in nearly all of the other cities in the State. The indications are that it would be feasible to diminish the consumption by preventing the leakage and waste of water to such an extent that the present sources might be adequate for the present requirements. Nevertheless, it is important that an additional supply should be secured to meet the growing needs of the city.

Analyses of samples of the water of West Brook, your proposed source of supply, collected during the month of October, at a time of low flow in the streams, show that the water is soft, has but little color, and is otherwise, in its present condition, of excellent quality for the purposes of a public water supply. Moreover, judging from the character of the water-

shed, it is probable that the quality of the water is not materially different at other seasons of the year, though its color may be somewhat higher at times. Compared with the water of Roberts' Meadow Brook, your present source of supply, the water of West Brook is found to have less color and to contain less organic matter, but is slightly harder. The water-shed of West Brook appears to contain but few inhabitants, and the water can be protected from pollution without special difficulty.

The water of Beaver Brook, into which it is proposed to turn the water of West Brook, has more color, hardness and organic matter, and is therefore of much less satisfactory quality than the water of West Brook; but the water-shed is small, and the water can probably be improved at small expense by draining the swamps. If the proposed storage reservoir upon this brook is properly prepared for the purpose by removing all the soil and organic matter from the entire area to be flowed, and the swampy areas on the water-shed thoroughly drained, it is likely that by carrying out the proposed plan a water of good quality will be obtained which will not be materially affected by growths of organisms or disagreeable tastes or odors.

In the course of this and previous investigations relative to additional water supply for Northampton and other places in its neighborhood, the Board has caused examinations to be made of the waters of various other sources which appear to be available as sources of additional water supply for Northampton.

The site of the old reservoir which formerly existed on the east branch of Mill River has been examined, and it is evident that an excellent reservoir could be constructed at this place from which a large additional supply for the city could be obtained. Examinations of the water of this stream at various times indicate that it is softer than the water of West Brook and of about the same character in other respects.

Examinations of the waters of both the east and west branches of Mill River above Williamsburg show that they are both of good quality and similar to the water of West Brook, though the water of the west branch has less hardness. There appear to be good opportunities for constructing reservoirs on both the east and west branches of Mill River, not far above Williamsburg; and if this is the case, a very large additional water supply for the city of Northampton could be obtained from either stream. The quality of the water would be likely to be satisfactory if stored in a reservoir properly prepared for the purpose.

The north branch of the Manhan River above Loudville has also been examined, and the quality of the water found, at the present time, to be about the same as that of West Brook. This stream also appears to be capable of furnishing an adequate supply of water for the city of Northampton, provided a suitable storage reservoir can be built upon the water-shed.

West Brook, either alone or in connection with a storage reservoir on Beaver Brook, can probably be developed so as to furnish an adequate additional supply of good water for the city of Northampton; but, with the limited amount of information at present available to the Board relative to the various sources, it cannot be said that West Brook would be the most appropriate source of supply for the city, nor is there any evidence to show that it may not be possible to obtain better water in equal quantity and at less expense from some of the other sources mentioned.

Considering the circumstances, it is advisable, in the opinion of the Board, to make more thorough investigations of all the available sources before deciding upon a plan for increasing the water supply of Northampton. These investigations should include examinations and surveys in the various water-sheds sufficient to determine the feasibility of constructing a reservoir or reservoirs of ample capacity for the future needs of the city, and the probable cost of such reservoirs, including the necessary expense of removing all soil and organic matter from the areas to be flowed and preparing them properly for the storage of water. Estimates should also be made of the probable cost of the pipe lines and other works for conveying the water to the city, and of the amount of damage that may be caused by the taking of land and diversion of water. The quality of the various waters should also be determined by frequent analyses at all seasons of the year. When this information is available, it will be practicable to select the source which is likely to prove most satisfactory in all respects for the future supply of the city. The Board would advise that these investigations be begun without delay, since much of the information can doubtless be obtained even in the winter season; and the Board will assist you by making the necessary analyses of samples of water from the various sources, and will, if you so request, advise you further in the matter when you have additional information to present.

While an additional supply is urgently needed, it seems very doubtful whether the necessary steps could be taken and a new supply introduced from the source proposed in time to meet the requirements of the next summer season in case the year should be a dry one; and, if the present sources should again become inadequate, it would probably be necessary, as at previous times, to draw water from Mill River in Northampton, — a polluted stream, the use of which as a source of domestic water supply should be avoided if possible. As already indicated, it is probable that the quantity of water used by the city is excessive, and, in the opinion of the Board, it is very important to determine the consumption of water by the city. It will then very likely be found practicable to reduce considerably the waste and leakage and prevent a shortage of water, should another dry season occur before an opportunity has been given to make the investigations outlined above, and to construct the necessary works for additional supply.

NORTHAMPTON INSANE HOSPITAL. An application was received, May 1, 1900, from the superintendent of the Northampton Insane Hospital, for advice relative to the use of the water of a certain spring upon the grounds of the hospital. The following reply was made to this application: —

JULY 5, 1900.

In response to your request of May 1, 1900, for advice as to whether the water from a spring on the grounds of the Northampton Insane Hospital is suitable to use for drinking purposes in the hospital, the Board has caused the locality to be examined by one of its engineers and samples of water collected from the well to be analyzed. The results of these analyses and of several made last year show that the water is generally clear, odorless and colorless; but it is quite hard, and the analyses show that the water has been at some time highly polluted, and that it is not always thoroughly purified in its subsequent passage through the ground to the well.

Considering the circumstances, the Board does not consider the well a safe source of water supply, and would advise that the use of the water from this source for drinking in the hospital be discontinued.

NORTHFIELD. An application was received, Aug. 27, 1900, from A. G. Moody of Northfield, for the advice of the Board relative to a proposed water supply for the Northfield schools, hotel and village of East Northfield. The Board replied to this application as follows: —

JAN. 3, 1901.

The State Board of Health received from you, on Aug. 27, 1900, an application for advice with reference to a water supply for the schools, hotel and village of East Northfield, to be taken from Perchog Brook or Louisiana Brook; and subsequently reports were received from your engineer, giving the results of investigations of various possible sources of water supply and estimates of the probable cost of works.

These investigations indicate that the flow of Louisiana Brook is much greater in proportion to its water-shed than the flow of Perchog Brook, and that it is likely that water of better quality can be obtained therefrom. The investigations also show that it is practicable to construct a storage reservoir on Louisiana Brook at a point where its water-shed has an area of about .15 of a square mile, which would have a storage capacity of about 6,000,000 gallons; and that, by taking water from the brook at a point about 1,000 feet below the storage reservoir, and utilizing the stored water, it will probably be practicable to obtain a sufficient supply of water for East Northfield for several years, though it is recommended that the present pumping station be maintained ready for use if necessary. It

is also suggested that it may be practicable to obtain a ground-water supply in the neighborhood of the present pumping station; but estimates of the cost of obtaining a supply in this way indicate that it would be considerably greater than by the proposed plan of developing Louisiana Brook.

The Board has considered the application and the reports submitted by your engineer, and has caused the locality to be examined by one of its engineers and samples of the water to be analyzed. The results of the analyses show that the water of Louisiana Brook, at the point at which the water would be taken to supply the town by gravity, is soft, but little colored, and otherwise of good quality for the purposes of a public water supply. The water of Perchog Brook has more color and contains a much larger quantity of organic matter than that of Louisiana Brook; and, while it is difficult to judge from a single analysis, made in the summer season, as to the quality of the water at other seasons of the year, it seems probable that the quality of the water of Louisiana Brook will usually be much better than that of Perchog Brook.

So far as can be judged from such observations as have been made, it seems probable that the flow of Louisiana Brook at the point at which it is proposed to locate the intake reservoir would be sufficient to supply the village during all but the driest months of the year, and a water of good quality at all times would be obtained in this way.

By constructing a storage reservoir farther up the brook, having a capacity of 6,000,000 gallons, as suggested, Louisiana Brook would probably yield by gravity a sufficient supply of water for the requirements of the village of East Northfield at all times for several years in the future, with a reasonable economy in the use of water. The water of a storage reservoir like the one proposed on Louisiana Brook is liable, even if the reservoir should be suitably prepared for the storage of water by the removal of all stumps and organic matter from the area to be flowed, to be unfavorably affected at times by growths of organisms, as suggested by your engineer, which impart to the water a disagreeable taste or odor; and, while it is not likely that trouble from tastes and odors would be very serious or long continued, it is desirable to avoid danger from this cause, if possible.

There does not appear to be any other source from which it is feasible to obtain an equally satisfactory independent supply of water by gravity.

The water of Louisiana Brook, in the lower portion of the course of the stream, is exposed to danger of pollution from buildings on its water-shed, and for this reason this brook, in the neighborhood of the present pumping station, cannot be considered a safe source of water supply.

An examination of the territory in the neighborhood of the mouth of Louisiana Brook indicates that it may be possible to obtain a large quantity of water from the ground in this region by means of wells or other suitable works, as suggested in the report of your engineer, and it is prob-

able that water of excellent quality would be obtained in this way which would not be affected at any time by a disagreeable taste or odor; but the cost of obtaining a sufficient supply at all times in this way would, according to the estimates submitted by you, be much larger than by the plan of taking the water of Louisiana Brook and constructing a storage reservoir as proposed. If, however, the natural flow of Louisiana Brook could be utilized by constructing the intake reservoir as proposed and omitting the storage reservoir, and if a sufficient supplementary supply could be obtained by pumping ground water from the neighborhood of the mouth of Louisiana Brook, it is probable that water of good quality would be obtained at all times. The first cost of the necessary works to supply the village in this way would, according to the estimates of your engineer, be considerably less than the first cost of works by the storage reservoir plan, and the annual cost of maintaining the works would not be materially greater than by the storage reservoir plan.

Considering the circumstances, the Board would advise that you cause investigations to be made, with a view to obtaining an adequate supply of ground water in the neighborhood of the mouth of Louisiana Brook for use as an auxiliary supply in addition to that obtained from the intake reservoir on Louisiana Brook during the summer season, whenever the yield of Louisiana Brook is insufficient to supply the entire quantity of water required by the town.

A suitable supply of water might be obtained from the Northfield Water Company, which is authorized by legislative act to supply water to the inhabitants of Northfield.

NORWOOD. The water commissioners of Norwood applied to the State Board of Health, Dec. 2, 1899, for its advice relative to a proposed system of water supply for the town, to be taken from driven wells on the easterly side of Neponset Street, about 600 feet from the intersection of Pleasant Street. The Board replied to this application as follows: —

FEB. 7, 1900.

The State Board of Health received from you, on Dec. 2, 1899, an application for advice with reference to a proposed additional water supply for the town of Norwood, in which you state that you propose to take water from driven or drilled wells on the easterly side of Neponset Street, in Norwood, at a point about 600 feet from the intersection of Pleasant Street; and subsequently you furnished the results of tests made at this place, which is in the south-westerly side of Purgatory Swamp, by sinking six tubular wells and by pumping from five of the wells for a period of two weeks, between Dec. 29, 1899, and Jan. 12, 1900, at a rate ranging from about 340,000 to 460,000 gallons per day.

The Board has caused the locality to be examined by its engineer and several samples of the water collected from the test wells at this place, both before and during the pumping test, to be analyzed.

Regarding the probable quantity of water which wells in this region can be expected to yield, a satisfactory estimate cannot be made with the information which is at present available; and, while water could be pumped from the ground with much freedom, and a large quantity was pumped nearly continuously during the test referred to, it cannot be stated definitely from the results of this test that an adequate additional supply for the town can be obtained by drawing water from the ground at this place.

Analyses of samples of water from the five wells, Nos. 2, 3, 4, 5 and 6, collected soon after the wells were completed, while found to differ considerably, indicated that the water had at some time been polluted by sewage and subsequently well purified in its passage through the ground. During the pumping test, which ended on January 12, water was pumped from wells Nos. 1 to 5, inclusive, and ten samples of water were collected in the course of the test. The results of the analyses of these samples showed in even more marked degree than those from the individual wells that some of the water entering the wells had been polluted, but at the time these investigations were made it was thoroughly purified in its passage through the ground before reaching the wells.

The source of the pollution referred to is probably the sewage discharged into the ground from the houses in the portion of the village nearest the wells, many of which are located at no great distance. The effect of this pollution upon the quality of the water was to make it somewhat hard, and the conditions are such that the water would be likely to become considerably harder if a sufficient additional water supply for Norwood should be drawn regularly from the ground at this place. Moreover, the information furnished by you as to the character of the soil in which the wells are driven shows that there is a layer of peat at the surface of the ground, which extends to a depth of about 11 feet; and, judging from experience with other ground-water supplies in similar situations, there is danger that water taken from the ground at this place will deteriorate and become affected by an excess of iron after a longer or shorter period of use, making the water objectionable for many purposes.

A comparison of the record of the quantity of water pumped for the supply of the town during the past year with the estimated capacity of the source of supply, indicates that the yield of the present source is insufficient to meet the requirements of the town in a dry period, and an additional supply is required. In order to determine whether it is practicable to supplement the present source, an examination has been made by the Board of the feasibility of diverting into Buckmaster Pond the water of any of the surface sources in its neighborhood. The only source from which it appears to be practicable to supplement the yield of the pond by

gravity is Colburn Brook, which could be diverted into the pond from some point near where it crosses the Medfield Road about half a mile west of the outlet of the pond. The results of analyses of the water of this brook show that it is highly colored and contains at times a considerable quantity of organic matter, due, probably, to the slow passage of the water through swamps. There are several dwelling-houses and other buildings situated close to the stream, and, if this source should be selected, provision would have to be made for preventing the pollution of the brook from these buildings. The water of Buckmaster Pond, while it has but little color, contains usually a larger quantity of organic matter than is found in a good surface water, and it has at times been very offensive to taste and smell, chiefly on account of the presence of certain microscopical organisms. It is not likely that any material improvement in the quality of the water of the pond would take place after supplementing it with the water from Colburn Brook, and it might have a somewhat higher color than at present. An examination of the bottom of the pond, at the end of last year, when the greater part of it was exposed, has shown that a considerable portion of its area is covered with mud and decomposing organic matter, which probably has an unfavorable effect upon the quality of the water, and it is not practicable to remove this mud while the source is being used for the supply of the town.

A good ground-water supply would be far more satisfactory to consumers than the water of the present source; and, if a supply sufficient for the needs of the town at all times, and which is capable of being developed to allow for the growth of the town in the future, could be obtained, it might be found more economical and otherwise satisfactory for the town to draw all the water from the new source, and discontinue the use of water from Buckmaster Pond.

Much of the soil in the lands bordering the Fowl Meadows, especially on the north-easterly side of the meadows which border Purgatory Brook, appears to be coarse and porous and favorable to the absorption of a large proportion of the water falling upon it; and it is possible that a supply of good water, adequate for the needs of Norwood, can be obtained from the ground in this region.

The Board would, therefore, advise that, before deciding upon a source of supply, you cause a further and thorough investigation to be made, with a view to determining whether it is feasible to obtain from the ground at any place in the region referred to a water of satisfactory quality and in sufficient quantity for the supply of Norwood. The investigation should be made under the direction of an engineer of experience in the selection of ground-water supplies, and should include a thorough test of the probable quantity and quality of water to be obtained at the place or places where the conditions are found to be most favorable for obtaining a satisfactory water supply.

It appears that a large proportion of the service pipes through which water is supplied to consumers in the town are of lead, or are lined with lead. In the course of investigations made by the Board, it has been found that most waters take up lead in passing through pipes of that metal, and in some towns numerous cases of lead poisoning have resulted from the use of water drawn through lead pipes. Your present supply acts considerably upon such pipes, but, so far as can be judged at present, the quantity of lead taken up has not been sufficient to cause lead poisoning. In selecting a new source, however, it is important, unless the lead service pipes in use be removed, to determine whether the water from the proposed source is likely to act upon lead sufficiently to be injurious to health.

The Board will, if you so request, assist you in any further investigations you may decide to make, by making such analyses of the water as may be necessary to advise you as to its quality and its probable action upon lead pipe.

Another application was received, Aug. 6, 1900, from the water board of Norwood, for advice relative to the quality of the water of the public supply of the town. The Board replied to this application as follows: —

Aug. 10, 1900.

In response to your request of August 6, the State Board of Health has considered the conditions affecting the quality of the water of Buckmaster Pond, and the results of the analyses of recent samples of the water. The analyses show that the water is of better quality than usual at this season of the year. The bad taste and odor sometimes occurring in this water, but not now noticeable, are undoubtedly due to the presence of organic matter, generally in the form of microscopic organisms not known to be injurious to health.

The purity of the supply is now threatened by the presence of a picnic grove not far from the shore of the pond; but at the present low stage of the water, serious danger from this cause can be prevented by preventing the deposit of sewage and fæcal matter in such a manner that it is liable to be washed into the pond. Provision should be made for properly disposing of all sewage and waste matter from this grove as soon as possible.

The investigations which have been made by the Board show that the presence of a considerable number of cases of typhoid fever in the town at the present time is due to polluted milk, and not to the public water supply.

Orange. An application was received, April 5, 1900, from the water board of Orange, for advice and information relative to the existence of a foul taste and odor in the water of the public water supply. The Board replied to this application as follows: —

MAY 4, 1900.

In response to your application of April 3, 1900, relative to the quality of the water drawn from faucets in the town of Orange, which you state has an oily and fishy taste and smell, which is very disagreeable, the Board has caused the sources of supply and the distributing reservoir to be examined by one of its engineers and samples of the water to be analyzed.

The water with which the town is now supplied is taken from a small basin, which is fed by a spring, the water of which is of excellent quality. The water in the basin is pumped to an open distributing reservoir and thence supplied to the town.

The cause of the disagreeable odor and taste is the presence in the water of considerable numbers of a microscopic organism known as *Uroglena*, which has in many other cases been found to impart to water a very offensive oily and fishy taste and odor, and the complaints as to the character of the water supplied to consumers are doubtless due to the presence of this organism in the water.

It has been well known for many years that a ground water deteriorates on exposure to light in an open reservoir, such as that in use at Orange; and experience has clearly shown that the remedy for this trouble is to keep the water from exposure to light from the time it comes from the ground until it reaches the consumer. To accomplish this in the case of the Orange water works it would be necessary to cover the basin and spring, and either to cover the present distributing reservoir or to build a new covered reservoir or tank, which may be of comparatively small capacity, and sufficient only for ordinary purposes, if the present reservoir is kept for use in emergency.

There is no reason to think that, if the quality of the water of your present source remains as good as it has been found to be, it will support any growth that will cause the water to deteriorate if kept entirely from exposure to light.

PEABODY. The board of health of Peabody applied to the State Board of Health, Feb. 10, 1900, for its advice relative to the quality of the water of a well used as a public drinking place in that town. The Board replied to this application as follows: —

MAY 4, 1900.

The State Board of Health has considered your application for advice with reference to the quality of the water of a well used to supply a public drinking place at the junction of Lowell and Forest streets in Peabody, and has caused the well and its surroundings to be examined and a sample of the water to be analyzed. The results of the analysis show that the water has been highly polluted by sewage and not thoroughly purified in its passage through the ground. There are several sources of pollution in the

immediate neighborhood of the well, and the circumstances are such that the Board regards the water unsafe for drinking.

It appears that one of the water mains of the town water works passes near the well, and, if it is desirable to maintain a public drinking place in this neighborhood, it would be best to use the town water for the purpose.

PEABODY. An application was received, Aug. 8, 1900, from the board of health of Peabody, relative to the quality of the water of a certain spring in that town, used for the water supply of a small factory. The Board replied to this application as follows: —

SEPT. 6, 1900.

In response to your request, received Aug. 8, 1900, for advice as to the quality of the water of a spring on an estate on English Street in Peabody, which supplies water for a factory, the Board has caused the spring and its surroundings to be examined by one of its engineers and a sample of the water to be analyzed.

The results of the analysis show that the water is clear, nearly colorless and odorless; but it is highly impregnated with sewage, apparently derived from the cesspools and other similar receptacles for sewage, of which there are a large number in the neighborhood of the spring, and the sewage has not been well purified in its passage through the ground to the spring.

The use of water from this spring for drinking is liable to be very injurious to health, and the Board would advise that its further use for drinking should be prevented.

SOUTHBOROUGH (St. Mark's School). An application was received, May 29, 1900, from the head master of the St. Mark's School at Southborough, for advice relative to the quality of the water supply of the school. The Board replied to this application as follows: —

JULY 5, 1900.

In response to your application of May 29 for advice with reference to the quality of the water supply of St. Mark's School, the Board has caused the well from which the supply is taken and its surroundings to be examined by one of its engineers and samples of the water to be analyzed.

The analyses show that the water is clear, odorless and colorless, and of good quality for drinking and other domestic purposes. There are no dwelling-houses in the neighborhood of the well, and its surroundings at present are such that there appears to be no danger of the pollution of the water from any source. The well appears to be capable of yielding suffi-

cient water for the present needs of the school, at least; and the Board is of the opinion that this well is a suitable source from which to take water for drinking and other purposes in the school.

SOUTHBRIDGE (American Optical Company). An application was received, July 27, 1900, from the American Optical Company of Southbridge, for the advice of the Board relative to the quality of the water of certain wells used as sources of water supply by the company. The Board replied to this application as follows: —

SEPT. 6, 1900.

In response to your request, received July 27, 1900, for advice as to the quality of the water of certain wells used in the factories of the American Optical Company for drinking purposes, the Board has caused the wells and their surroundings to be examined by one of its engineers and samples of their waters to be analyzed.

A sample of water collected from the group of wells located in the factory on Mechanics Street was found from analysis to be clear and colorless, but it contained a slightly larger quantity of organic matter than is found in a good well water. The analysis does not indicate that the water is at present unsafe for drinking; but the Board would advise that it be analyzed from time to time, to observe whether any deterioration takes place in its quality.

The analysis of a sample of water from the well located in the factory at Lensdale shows that a considerable portion of the water entering this well has previously been polluted by sewage and that it has not been well purified in passing through the ground to the well. The Board would advise that the further use of water from this well be prevented.

A sample of water was also collected from a spring on the opposite side of the river from the Lensdale works, and the results of the analysis show that the water is clear, colorless and odorless, and, in its present state, of good quality for drinking. The location of the spring is such, however, that, if a large quantity of water should be drawn from a well or wells at this locality, a portion of the water might come by filtration from the river, and its quality might become very different from what it was found to be at the time the recent sample was collected. It is probable that water of good quality can be obtained from the ground on the opposite side of the river from the Lensdale works, if the water is collected at a sufficient distance from the river to avoid danger of drawing unpurified water from that source.

SOUTHBRIDGE (Dexter Harrington & Son). An application was received, July 16, 1900, from D. Harrington & Son of Southbridge,

for the advice of the Board relative to the quality of the water of a certain well used by the operatives in their factory. The Board replied to this application as follows: —

Sept. 6, 1900.

The State Board of Health has considered your application for advice with reference to the quality of water from a certain well which is used for drinking in your factory, and has caused the locality to be examined by one of its engineers and a sample of the water to be analyzed.

The results of the analysis show that the water in its present state is odorless and nearly clear and colorless, but it contains a somewhat larger quantity of organic matter than is usually found in good well water. This analysis does not show that the water, as supplied from this well at the time the sample was collected, was unsafe for drinking purposes; but there are several sources of pollution in its neighborhood, and changes in the height of the ground water and other circumstances may at any time render it unsafe. Hence the Board cannot recommend its continued use for drinking purposes.

Springfield. An application was received, July 24, 1899, from the water board of Springfield, for advice relative to the public water supply of the city, the subjects indicated in the application being the advisability of cleaning the Ludlow Reservoir and of taking certain additional sources of supply, mainly the west branch of the Swift River, the Westfield River and certain sources in Blandford. Advice was also asked relative to the subject of the filtration of the water of Ludlow Reservoir. In a later application, dated Jan. 24, 1900, advice was also asked relative to the use of the north branch of the Westfield River as a source of supply for Springfield. The Board replied to these applications as follows: —

May 11, 1900.

The State Board of Health received from you, on July 24, 1899, an application requesting the advice of the Board as to the present and future sources of water supply of Springfield, taking into consideration the feasibility of improving the water of Ludlow Reservoir by various methods, of taking water from the west branch of the Swift River, of taking water from the Westfield River and also from other sources. Subsequently you caused the water of Ludlow Reservoir to be drawn out, to afford an opportunity for an examination of the bottom of the reservoir, and caused soundings to be made, showing the depth of mud and organic matter in the bottom of the reservoir. On Jan. 24, 1900, you submitted the following outline of your proposed plan for supplying water to Springfield: —

It is proposed to take water in such quantity as may be needed for the future supply of the city from the north branch of the Westfield River or any of the tributaries of that branch, at points above Norwich bridge, so called, in the town of Huntington, by constructing such dam or dams as may be necessary for the purpose of creating storage reservoirs for equalizing the variable flow of the streams impounded, and conveying the water from such reservoirs in a cast-iron main or mains of proper size through the easterly part of the village of Huntington to and in part through the State highway leading down the valley of the Westfield River through the towns of Russell, Westfield and West Springfield to the city of Springfield, crossing the Connecticut River on a suitable bridge or bridges It is proposed to remove all objectionable matter found within any storage basin area, and to exercise all reasonable care to prevent future pollution of the water in any case.

The elevation of the bed of the north branch at the confluence of its two main tributaries next above Norwich bridge is about 395 feet above mean sea level, or about 20 feet above the overflow level of Ludlow Reservoir, the present principal source of supply of Springfield. By the construction of dams the water may be raised to an elevation of 450 feet above mean sea level.

The main tributaries of this north branch of the Westfield River consist of an easterly branch flowing southerly through the towns of Savoy, Windsor, Cummington, Chesterfield and Worthington, and a westerly branch flowing southerly through the towns of Peru, Worthington, Middlefield and Chester. The watershed areas above the confluence of these two branches are, for the easterly branch, a little more than 160 square miles; for the westerly branch, about 50 square miles.

The city of Springfield will offer no objection to the reservation of rights in this stream or its tributaries to the adjacent cities of Holyoke and Northampton, provided it [the city of Springfield] is granted the unrestricted right to take from these sources any and all the water it may need in the future for all the various uses of its inhabitants, and is protected in its investments made for the purpose.

Later, a report and plans by Mr. Percy M. Blake, civil engineer, giving the results of investigations with reference to the present and proposed water supply of Springfield, were submitted, and information was furnished as to the areas within the water-shed of the Westfield River, which it is proposed to reserve for the water supply of the city of Holyoke.

In response to your applications, the Board has examined Jabish Brook, Ludlow Reservoir and the other sources now used for the supply of Springfield, and has caused an examination of the proposed sources to be made by its engineer and samples of the water to be analyzed. The Board has also examined the results of previous investigations of your present sources of supply, and has carefully considered the plans and information submitted.

Your present source of supply, Ludlow Reservoir, furnishes a water which has nearly always been very objectionable on account of an offensive taste and odor caused by the presence of large numbers of microscopical organisms; and there is no indication that the quality of the water has improved since the works were constructed, twenty-five years ago. The trouble is

doubtless caused principally by the great deposits of mud, stumps and organic matter in the bottom of the reservoir; but the character of the water-sheds of the streams which feed the reservoir is not satisfactory. The water-shed of the principal feeder, Jabish Brook, contains a storage reservoir and several mill ponds, which have not been properly prepared for the storage of water, together with considerable areas of swamp land, and the water takes up large quantities of organic matter both from the ponds and the swamps. The discharge of this water into the reservoir during the past few years has apparently made its condition worse.

Three ways of improving the water of Ludlow Reservoir have been suggested: first, by removing all of the mud and organic matter from the area covered with water when the reservoir is full; second, by removing the mud and organic matter from the portions where the depth of mud is small, and covering with sand the places where the depth is so great that the cost of covering would be less than the cost of removal; third, by filtering the water, leaving the reservoir practically in its present state.

Ludlow Reservoir, with its tributary water-sheds and canals, if the capacity of the latter was large enough to convey all of the flow of the streams which are tapped by them into the reservoir, would be sufficient, judging from the growth of the city, to supply Springfield until about the year 1923; and, even allowing a considerable loss of water from various causes, this source would probably be sufficient for nearly twenty years. But under present conditions the capacity of the canals is not sufficient to convey the higher flows of the tributary streams into the reservoir, and large quantities of water are lost. To secure the full capacity of the present works and to provide for a supply from Ludlow Reservoir sufficient for twenty years, the capacity of the canal system must be greatly enlarged. After the full capacity of Ludlow Reservoir and its present tributary water-sheds has been reached, it appears that the only available source from which a supplementary supply can be obtained is the west branch of Swift River, the water-shed of which lies easterly from the water-shed of Jabish Brook. The water of Swift River can be conveyed into Ludlow Reservoir, either by a conduit 17.4 miles long, which would convey the water by gravity, or by pumping the water a distance of about two and one-half miles to an elevation of nearly 200 feet. By either plan a quantity of water could be obtained, which would, in conjunction with Ludlow Reservoir, be capable of supplying the city of Springfield probably for the next forty years.

The first plan of improving Ludlow Reservoir, suggested above, that of removing the mud from the bottom of the reservoir completely, would be an expensive one in any case. There is, moreover, much doubt as to the feasibility of removing this mud completely and disposing of it in a satisfactory manner; and, if the plan should be tried, complications might arise which would make it impracticable to do the work as thoroughly as it ought to be done. In connection with this plan, it would be essential to improve

the quality of the water from the water-sheds which now supply the reservoir, and from which large quantities of organic matter now find their way into the reservoir, and to enlarge the capacity of the canals. If it were feasible to thoroughly clean all mud and organic matter from Ludlow Reservoir and to drain all swamps and clean the bottoms of the ponds and reservoirs on its tributary water-sheds, or remove their dams and drain them, a very great improvement would be made in the quality of the water over its condition at present, and, as already stated in a previous reply of the Board, the indications are, judging from experience in other places, that the water would generally be of excellent quality; but it might still at times be affected by the presence of organisms which impart to water a disagreeable taste and odor.

The second method of improving this reservoir that has been considered is to remove the mud and organic matter from portions where its depth is not excessive, and cover the remainder with sand. The experience in covering a portion of the bottom of this reservoir with sand to a depth of eighteen inches twenty-five years ago was a satisfactory one, in that the sand has remained in place to the present time, and this method of treating such deposits of organic matter in storage reservoirs is now being tried in other places in the State. But in the main portion of Ludlow Reservoir the conditions have evidently changed materially since the ground was first cleared for the storage of water, and there is evidence that a considerable portion of the roots and fibrous matter in the upper layer of the mud has become decayed. The condition of the bottom is such at the present time that it seems very doubtful whether it would support efficiently a layer of sand of such depth as would prevent the water from coming in contact with the organic matter beneath, unless some extra provision should be made for supporting the covering material. If the work could be successfully performed, it would still be necessary to clear the remaining portions of the reservoir and improve the water-sheds of tributary streams and enlarge the canals, as in the case of the plan previously considered, and the results, as in the former case, might not be wholly satisfactory in improving the quality of the water.

The third method suggested, of securing a supply of good water from Ludlow Reservoir, is to filter the water through prepared beds of sand. In a previous reply of the Board, in 1897, in response to a request from your board for advice as to improving the quality of the water of Ludlow Reservoir, the Board advised you to construct experimental filters in the vicinity of the reservoir, and make experiments upon the filtration of this water during that portion of the year when the water contains an excessive amount of vegetable matter, beginning about the first of May and continuing until nearly the end of the year. The Board offered to assist you in these investigations by advising you as to the construction and operation of experimental filters, and by making all necessary examinations of water. It does

not appear that any investigations such as were suggested have been made, nor has the Board information as to any place where such a water has been effectually purified by filtration. Moreover, no investigations appear to have been made upon the purification of a water of this sort which would furnish information as to the feasibility of purifying it effectually and as to the design and probable cost of the necessary works.

The feasibility of building a dike around the portion of Ludlow Reservoir in which the depth of mud is excessive, and cleaning thoroughly the remaining portion of the reservoir, has also been considered. By this plan the capacity of the reservoir would be materially reduced and a large portion of the reservoir that would remain would be undesirably shallow, and with this condition there would be much danger that the water would still be affected by the presence of organisms which would give it a disagreeable taste and odor.

The plan proposed in your recent application, for securing a suitable supply of water for the city of Springfield, is to take water from the north branch of the Westfield River, so called, above Norwich bridge in the town of Huntington by the construction of one or more storage reservoirs on the main stream or one of its tributaries, and a pipe line to convey the water to the city.

The portion of the Westfield River described drains an extensive but very sparsely settled area, including several very small towns in which the population has been steadily decreasing for many years. The sources of possible pollution of the water on this area are comparatively few and it should not be difficult to protect the purity of the water supply.

Upon the plans accompanying the report of your engineer two possible sites for storage reservoirs are shown in considerable detail, one located on the stream called the middle branch of the Westfield River, a short distance above its confluence with the east branch, and the other upon the east branch, just above the mouth of the middle branch. Your investigations show that these reservoirs would be of about the same capacity, but the reservoir on the middle branch would be somewhat more expensive to construct than the reservoir on the east branch.

Several samples of water have been collected since September last, both from the main stream and the middle branch, at the sites of the proposed reservoirs, and the results of analyses of these samples show that the waters of both streams are soft, generally clear and but little colored, and of excellent quality for the purposes of a public water supply. At times, after heavy rains, the water of both streams is more turbid and colored, and contains a larger amount of organic matter than usual; but, by the construction of a storage reservoir, the variation in the quality of the water at different times would be greatly lessened. Of the two waters, that of the middle branch is slightly better in quality than that of the east branch, but the difference is not great.

In the absence of definite records of the flow of the streams in this territory in very dry years, it is difficult to form a satisfactory estimate of the probable yield of the proposed reservoirs. So far as can be judged, from our present information, the proposed reservoir on the middle branch will yield sufficient water for the supply of the city for many years, but, on the other hand, it is possible that its capacity might soon be reached if this source alone should be used for the supply of the city. The east branch, with the proposed storage reservoir, would furnish a much larger quantity of water than the middle branch, and the yield of the east branch, with the proposed reservoir, would be considerably greater than the quantity now required for the supply of Springfield, even allowing that about 37 square miles of water-shed may be diverted for the supply of the city of Holyoke. But the city of Springfield is growing rapidly; and it is probable that, if the proposed works are built, the town of West Springfield can obtain a supply from them more satisfactorily than in any other way, and in the future it is not unlikely that other districts in the immediate neighborhood of Springfield may find it desirable to secure a supply in connection with the Springfield works. Under the circumstances, it will probably be necessary at some future time for the city to use the water of both branches, and there would be much advantage in making both branches available for use in the beginning.

If all areas to be flooded with water by the construction of reservoirs should be thoroughly cleaned by the removal of all mud and organic matter, the Board is of the opinion that a water of excellent quality would be obtained from each branch, which would not be subject to disagreeable tastes and odors, and that the proposed source of supply would be capable of furnishing all the water that Springfield would require for a very long time in the future, even allowing that about 37 square miles of water-shed might be diverted for the supply of the city of Holyoke. The cost of a supply from the Westfield River would probably be somewhat greater than the cost of filtering the water of Ludlow Reservoir and providing an additional supply from Swift River; but, considering all the circumstances, the Board is of the opinion that the east and middle branches of the Westfield River, which form the so-called north branch, are appropriate, and would be satisfactory sources of water supply for the city of Springfield.

SPRINGFIELD. An application was received, July 28, 1900, from the board of health of the city of Springfield, for the advice of the State Board of Health relative to the quality of the water of two springs in that city which were being used as drinking water. The Board replied to this application as follows: —

AUG. 10, 1900.

In accordance with your request of July 28 for advice as to the quality of the water of two springs in Springfield from which much water is used

by the public, the State Board of Health has caused the springs and their surroundings to be examined and samples of their water to be analyzed.

There is a considerable population in the territory which apparently drains toward the Ingersoll Spring, but there appear to be no sources of pollution in its immediate neighborhood.

The analysis of the water of this spring shows that some of the water entering the spring has been polluted by sewage, but has subsequently been well purified in its passage through the ground. The examinations made by the Board indicate that the water of this spring in its present state is safe for drinking, but it is desirable, on account of the situation of this spring, that analyses of the water be made from time to time, in order that any deterioration in its quality may be detected.

Dickinson Spring, so called, located on Chestnut Street, is situated in the densely built-up portion of the city. The analysis shows that the water is clear, colorless and odorless; but it is quite hard, and has evidently at some time been highly polluted by sewage and not thoroughly purified in its subsequent passage through the ground to the spring.

The circumstances are such that the Board does not consider this spring a safe source of drinking water supply, and would advise that the use of water from this source be prevented.

Tufts College. An application was received, Sept. 10, 1900, from the president of Tufts College, for advice relative to the use of the water of a well on the college grounds for drinking purposes. The Board replied to this application as follows: —

Oct. 4, 1900.

In response to your request for an examination of the water from the well on the Tufts College grounds, which it appears is used by the students and others for drinking, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results indicate that some of the water entering the well has at some time been considerably polluted, probably by the annual dressing put upon the grass, and not thoroughly purified in its subsequent passage through the ground to the well. Judging from the examination, there is considerable doubt as to whether the water is safe for drinking; and, since water of excellent quality from the public water supply is available for drinking at the college, the Board would advise that the use of this well as a source of drinking water be avoided.

Wareham, Marion and Mattapoisett. An application was received, Dec. 19, 1900, from Edgar Welch and others, for the advice of the Board relative to a proposed water supply for the towns of Wareham, Marion and Mattapoisett, the sources of supply named

in the application being Mary's Pond in Rochester, Blackmore's Pond in Wareham and driven wells at some point near the Sippican River. The Board replied to this application as follows: —

JAN. 3, 1901.

The Board has caused the two ponds mentioned in your application to be examined by its engineer and samples of the water from each of them to be analyzed. The analyses show that at the time this examination was made the water of Blackmore's Pond was soft, clear and colorless and otherwise of good quality for the purposes of a public water supply; but the area of the water-shed of the pond, so far as can be judged from the information available, is so small, that, considered in connection with the small area of the pond, it is not probable that a sufficient supply of water for the three towns mentioned in your application could be obtained from this source after public water supplies in these towns had come into general use.

The water of Mary's Pond, like that of Blackmore's Pond, is soft and free from turbidity or color, and is in other respects of somewhat better quality than the water of Blackmore's Pond. Whether the yield of this pond would be sufficient for the supply of all of the towns after water had come into general use cannot be determined from the information now available to the Board; but the indications are that this source would yield sufficient water for the supply of the three towns for several years after the works were constructed.

It is not practicable to tell from a single analysis, especially at this season of the year, what the quality of the water may be at other seasons. Judging from experience with similar sources, it seems probable that the water of this source will generally be of excellent quality; but it is likely that at times it will be affected by the presence of organisms which have caused disagreeable tastes and odors in other ponds and reservoirs.

With regard to the third source mentioned, — driven wells near the Sippican River, — it appears that no definite location has been selected.

A good ground water would be more satisfactory for drinking and other domestic uses than the water of Mary's Pond or other surface source, on account of its freedom at all times from disagreeable tastes and odors; and, under the circumstances, the Board would advise that investigations be made to determine whether it is practicable to obtain a sufficient supply of good ground water for these towns before definite plans are prepared for taking water from any surface source.

If you should decide to make further investigations, with a view to obtaining a ground-water supply, the Board will assist you, if you so request, by making such analyses as may be necessary of samples of the water, and will give you further advice in the matter when you have the results of investigations to present.

Wenham and Hamilton. Geo. W. Fitz of Wenham applied to the Board, March 24, 1900, for advice relative to the propriety of supplying the towns of Wenham and Hamilton with water from the valley north of Brown's Hill in Hamilton. The Board replied to this application as follows: —

May 4, 1900.

The State Board of Health has considered your application for advice with reference to the use of water from a spring a short distance north of the Essex Branch Railroad and half a mile east of Hamilton station, for the supply of the towns of Wenham and Hamilton, and has caused the locality to be examined by one of its engineers and a sample of water from the spring to be analyzed. The results of the analyses show that the water is clear, colorless and quite soft, and otherwise of good quality for a public water supply. At the present time the quantity of water flowing from the spring is probably ample for the requirements of the towns which it is proposed to supply; but it is not practicable to tell, from information available to the Board, whether the yield of the spring would be ample in the drier portions of the year, or whether the quality of the water would be liable to deteriorate if a large quantity of water should be drawn from the ground in this region. The Board would therefore advise that, before preparing plans for the use of the source for the supply of Wenham and Hamilton, you cause further examinations to be made, to determine the probable yield of the source and the quality of the water. The Board will cause such further analyses of the water to be made as may be necessary during the next few months, if you will collect the samples, and will, if you so request, give you further advice in the matter when further information is available as to the probable quantity and quality of the water.

A second application was received, July 19, 1900, from George W. Fitz of Wenham, for the advice of the Board relative to a proposed water supply for the towns of Wenham and Hamilton. The Board replied to this application as follows: —

Jan. 3, 1901.

The State Board of Health received from you, on July 19, 1900, an application for advice with reference to a proposed source of water supply for the towns of Hamilton and Wenham, in which you state that it is proposed to obtain the supply from wells in the valley of Miles River in the neighborhood of Brown's Hill, and that tests were then being made by means of tubular wells. After the application was received additional test wells were put in by you in the region designated, and subsequently a large test well with tubular wells driven in its bottom was dug at a point in the valley of Miles River, just north of the Essex Branch Railroad and about

half a mile east of the Hamilton station. A pumping test was then made by pumping water from this well continuously at a rate of about 200,000 gallons per day from Dec. 9 to Dec. 18, 1900, with the exception of a stop of several hours on December 10 and 11.

The Board has caused the locality to be examined by its engineer and analyses to be made of samples of the water of the tubular test wells and of the water drawn from the large well during the pumping test. The wells are located in the immediate neighborhood of the spring concerning the use of which, as a source of water supply for Hamilton and Wenham, the Board advised you last year.

The region is sparsely settled, and the purity of water taken from the ground in this region can be protected without special difficulty. The results of the recent pumping tests show that water can be drawn freely from the ground at this place in large quantities, and the indications are that a sufficient quantity of water for the supply of Hamilton and Wenham for many years can be obtained from the ground in this region by means of suitable works.

The water of many of the test wells was found upon analysis to contain iron in such quantities that this water would be unsatisfactory for many domestic purposes. In the water of some of the test wells the quantity of iron present was small, and the large test well was located at a place where one of the previous tests had shown that the quantity of iron present in the water was not excessive. Samples of water from the large well collected at frequent intervals were found upon analysis to contain only a very small quantity of iron; and the water was also soft, generally clear, colorless and free from odor, and contained but little organic matter. In its present state the water would be of excellent quality for all domestic purposes.

While the investigations thus far made have been as thorough as practicable under the circumstances, it is not possible to predict from them whether the quality of the water would change if a quantity sufficient for the supply of the towns of Hamilton and Wenham should be drawn continuously from the ground in the neighborhood of the location of the large test well. The location, however, is not far from the large spring mentioned in your former application, which furnishes a water of excellent quality, and there are other springs in the neighborhood. If works should be constructed for taking water from a well near the location now suggested, and the water should deteriorate sufficiently in quality to make a change in the source desirable, it would probably be practicable, without special difficulty, to secure an ample supply of good water from the large spring referred to and other springs in the immediate neighborhood.

Considering all the circumstances, the Board is of the opinion that a sufficient supply of water of good quality can be obtained in the region referred to in your application to warrant the construction of works for supplying water to the towns of Hamilton and Wenham.

West Springfield (the Southworth Company, Mittineague). An application was received, Oct. 16, 1900, from the Southworth Company, for advice relative to the quality of the water of certain springs used by the company for the supply of its tenement-houses in that village. The Board replied to this application as follows: —

Dec. 6, 1900.

In response to your application of October 16, for advice with reference to the use of water from certain springs in the village of Mittineague for the supply of tenement-houses of the Southworth Company, the Board has caused the locality to be examined by one of its engineers and samples of water of the proposed sources to be analyzed. Analyses of the water from the springs used to supply these houses at present show that it is quite hard, and has at some time been considerably polluted by sewage and that it has not been thoroughly purified before entering the springs. The springs from which it is proposed to take the supply in the future are located at a somewhat higher level than the present sources; but there is a considerable population above them, and analyses of the water of the springs show evidence of pollution from this population. The proposed sources, moreover, judging from the information available as to the flow of the springs, are unlikely to furnish a sufficient quantity of water for the population which you propose to supply from these sources. Under the circumstances, the Board does not advise the use of these springs as sources of water supply for the houses referred to in your application, and advises that the use of water from the springs from which the present supply is drawn be discontinued.

Winchendon (White Bros.). An application was received, Jan. 19, 1900, from White Bros. of Winchendon Springs, for advice relative to the quality of the water of a spring at Winchendon Springs. The Board replied to this application as follows: —

June 8, 1900.

In response to your request for advice as to the quality of the water of a spring at Winchendon Springs, the State Board of Health has caused the spring and its surroundings to be examined and a sample of the water to be analyzed. The results of the analysis show that the water is clear, colorless and odorless, but it has evidently been somewhat polluted by sewage, probably from houses on the higher lands sloping toward the spring, and the water has been subsequently partially purified in its passage through the ground. One characteristic of the water is the excessive quantity of iron in solution, which, when the water is exposed to the air, gradually oxidizes and separates out of the water, forming a rusty precipi-

tate. While in its present state this water may not be unsafe for drinking, it is not a desirable drinking water, and, considering the circumstances, the Board would advise that its use be avoided.

Sewerage and Sewage Disposal.

The following is the substance of the action of the Board during 1900 in reply to applications for the advice of the Board relative to sewerage and sewage disposal, under chapter 375 of the Acts of 1888, or for the approval of sewerage systems or the taking of land for sewage disposal, under other acts: —

Barnstable (State Normal School at Hyannis). The board of health of Barnstable applied to the State Board of Health, May 29, 1900, for its advice relative to the disposal of the sewage of the State Normal School at Hyannis. The Board replied to this application as follows: —

June 8, 1900.

On May 31 a communication was received by this Board from George W. Doane, M.D., member of the board of health of Barnstable, Mass., relating to the present method of disposing of the sewage of the State Normal School at Hyannis, the prevention of further nuisance from odors in the neighborhood, and the pollution of the brook into which the sewage now flows; and in response to this request the State Board of Health has caused the locality to be examined by one of its engineers and samples of the water from the brook which receives the sewage to be analyzed.

It appears that the sewage is at present discharged into a cesspool, from which it overflows on an area of marshy land and finds its way to a brook, causing a serious nuisance, and a suitable method of sewage disposal should be provided with as little delay as possible.

The circumstances are such that it does not appear to be practicable to dispose of the sewage by discharging it into cesspools, and the best way of disposing of the sewage of the school would be to convey it to areas of sandy land and purify it by intermittent filtration. It is possible that the sewage can be conveyed by gravity to the sandy lands in the neighborhood of the marsh or near the railroad, and that filter-beds can be prepared on these lands, which will have a depth of five feet of sand or gravel above the water level of the marsh or the brook which flows from it. In that case, by preparing four beds, each about twenty-five feet square and surrounded by embankments, and by discharging the sewage on each bed alternately for a period of not more than two days at a time, the sewage will be efficiently purified if the beds are given the small amount of care that is necessary to keep the surface in proper condition. It is desirable to collect the sewage in a tank, from which it will be discharged automati-

cally at intervals of several hours. If a suitable area in which the soil is adapted to the purpose cannot be found, upon which the sewage can be discharged by gravity, it is probable that filter-beds of a depth of four or five feet can be constructed on the marsh, of the sandy or gravelly material found in the lands about it.

If you will select a location for the filter-beds and prepare outlines of a plan by which the sewage can be conveyed to them, the Board will give you further advice in the matter, if you so request.

BARNSTABLE (State Normal School at Hyannis). An application was received, Sept. 13, 1900, from the principal of the State Normal School at Hyannis, for advice as to the efficiency, location and arrangement of the filter-beds used for the sewage disposal of the school. The Board replied to this application as follows: —

DEC. 6, 1900.

On Sept. 13, 1900, the State Board of Health received from you a communication stating that you have established filter-beds upon which the sewage of the State Normal School at Hyannis is now discharged, and requesting the Board to inspect the premises and advise you as to the efficiency, location and arrangement of the filter-beds; and in response to this request the Board has caused the locality to be examined by its engineer.

It appears that the sewage is collected in a large cesspool, capable of holding a day's flow of sewage or more, and it is evident that the sewage decomposes and putrefies to a considerable extent in this cesspool, so that when it is discharged upon the filters the odor is noticeable in the neighborhood. If the use of the cesspool should be discontinued and the sewage discharged directly upon the beds, it is probable that the odor will be less noticeable than at present. Nevertheless, there will be much advantage, in the opinion of the Board, in removing the location of the filters to a greater distance from dwelling-houses.

It appears to be practicable to prepare an area of gravelly land at a considerable distance east of the present filter-beds and more remote from dwelling-houses; and, if the sewage should be applied beneath the surface of the area, there would be very little danger that any odor from it would be noticeable in the neighborhood. While the experience with the application of sewage to pipes beneath the surface of the ground has shown that they will become clogged after a longer or shorter period of use, so that it is necessary to take them up and clean and relay them in order to secure efficient disposal of the sewage, this method of disposal would, nevertheless, in this case, probably prevent any further complaint of odors from the sewage. If an area of at least four thousand square feet should be pre-

pared for the purpose, it is not likely that the relaying of the pipes will be necessary oftener than once in two years, and may not be found necessary for a longer period. The pipes for the distribution of the sewage should be laid not over three feet apart and about two feet beneath the surface, with open joints surrounded by gravel in such a manner that sand cannot enter the joints, while, on the other hand, the sewage can pass out quite freely from them. It is probable that it will not be necessary to underdrain the filters, but provision should be made for discharging the sewage intermittently into the pipes; and for this reason the area should be divided into three or four systems of pipes, so that the different parts of the area can be used in rotation, and opportunity given for sewage to soak away and air to enter the ground.

The Board will, if you so request, give you further advice in the matter when you have prepared a plan for the further disposal of the sewage.

Brockton. The board of health of Brockton applied to the State Board of Health for its advice, Feb. 2, 1900, relative to the propriety of allowing certain waste products from the Douglas Shoe Factory to discharge into the Salisbury Plain River. The Board replied to this application as follows: —

May 4, 1900.

In response to your application of Feb. 2, 1900, for the advice of this Board relative to the disposal of waste liquors from the Douglas Shoe Factory in Brockton, the Board has caused the locality to be examined by its engineer, and finds that the discharge into the Salisbury Plain River of certain liquors used in treating leather in this factory is creating a nuisance. It appears that these liquid wastes are passed through a settling basin with the object of removing matters in suspension, but that the tank has not been cleaned out as frequently as necessary, so that much suspended matter has been discharged into the stream at times.

Since your application was submitted, it appears that the city government has begun preparations for extending the sewerage system of the city as far as the Douglas Shoe Factory during the coming summer, and it is probable that it will soon be possible to discharge all of the offensive wastes from the factory into the city sewers, and thus dispose of them in a satisfactory manner. Under these circumstances it does not seem essential, in the opinion of the Board, to make any further provision at present for disposing of these wastes; but during the short time before the sewer is completed and ready to receive them, the tank through which the liquid passes should be cleaned out as frequently as may be necessary, to intercept as much as possible of the solid matter and prevent it from entering the river.

Chicopee. An application was received, June 15, 1900, from the mayor of Chicopee, relative to the proposed removal of the out-

let of a sewer in Montgomery Street, Chicopee Falls, from its location east of the Chicopee River bridge to a point above the dam of the Chicopee Manufacturing Company. The Board replied to this application as follows: —

JULY 5, 1900.

The State Board of Health received from you, on June 15, an application for advice with reference to the removal of the outlet of a sewer in Montgomery Street, Chicopee Falls, from the present outlet just east of the Chicopee River bridge to a point of discharge above the dam of the Chicopee Manufacturing Company. You state that the discharge of sewage into the Lamb Manufacturing Company's pond, the present place of disposal, creates a nuisance during warm weather, when the mill pond is drawn off and no water is passing over the dam above it; and you propose to remove all of the dry-weather flow of sewage and a large part of the flow at times of storm to the new outlet.

The Board has caused the locality to be examined by one of its engineers and has carefully considered your application and the plan submitted therewith. There is no doubt that the present method of disposing of the sewage from the Montgomery Street sewer creates a very serious nuisance in the summer season, and it is desirable to remove all of the sewage from that sewer to some suitable place of disposal. The removal of the outlet of the sewage from its present location to the mill pond above the dam of the Chicopee Manufacturing Company will, in the opinion of the Board, materially relieve the objectionable conditions now complained of, and the change will not be an expensive one to make; but the water in the Chicopee Manufacturing Company's mill pond at the proposed point of discharge has but little current during a considerable portion of the year, and the discharge of sewage into this mill pond is liable to give trouble by causing deposits in the pond and offensive odors at times of low water after the outlet has been in use for a time.

It is desirable that the sewage be removed from the river above the dams in this city and disposed of in some suitable manner. The proposed plan should, therefore, be considered a temporary one, to be abandoned when a suitable means of disposing of the sewage has been provided.

An application was received, June 1, 1900, from the mayor of Chicopee, for advice relative to a proposed system of sewerage and sewage disposal for the villages of Willimansett and Aldenville, having an outlet into the Connecticut River. The Board replied to this application as follows: —

JUNE 8, 1900.

The State Board of Health received from you, on June 1, 1900, an application for advice with reference to the disposal of the sewage of the village of Aldenville and a portion of the village of Willimansett in the city of

Chicopee, accompanied by a plan showing the location of the proposed sewer system and outlet. The plan provides for a main sewer, beginning in Grattan Street, a short distance south of Chapel Street in Aldenville, and running through Grattan Street to Willimansett, and along Alden, Nassau, Chicopee and Perry streets to the Connecticut River, where it is proposed to place the outlet at low water and discharge the sewage into the river through a few feet of submerged pipe.

You propose to construct the system of sewers for Aldenville upon the separate plan, excluding storm water; but in Willimansett you propose to provide a combined system, to remove both sewage and storm water. Your plan also includes a drainage system to lower the level of the ground water in Aldenville, the outlet of the system to be into a deep ravine, from which the water would find its way ultimately into the Connecticut River.

The Board has caused the locality to be examined by one of its engineers and has carefully considered the plans and information submitted. The proposed method of disposing of the drainage and sub-soil water from the village of Aldenville by discharging it into the dingle, so called, is a satisfactory one, provided that all sewage be kept out of the drains or channels receiving drainage. It is unnecessary to convey the storm water from the village of Aldenville to the Connecticut River, since this water can be disposed of into natural water courses without objection, and a large saving in expense will be made by keeping the sewage separate from the storm water. In the village of Willimansett, which lies quite close to the river, it will probably be less expensive to provide a combined system of sewers, as proposed, taking both the sewage and storm water in the same pipes.

The plans submitted do not show the grades of the sewers, and the Board is unable to advise you as to their capacity; but it is understood that the proposed sewer through Willimansett is not expected to be of sufficient size to provide for the removal of the rain water from all of the district which might be made tributary to the sewer, and that other means of disposing of the storm water will have to be provided at some future time. The proposed method of disposing of the sewage by discharging it into the Connecticut River is the best that it is practicable to adopt; but it is essential, in order to avoid a nuisance along the river bank, that the ordinary flow of sewage be conveyed to a sufficient distance from the bank to prevent floating matters from returning and collecting upon it, and causing an odor in the vicinity of the outlet.

The plan as a whole is, in the opinion of the Board, a suitable one for the collection and disposal of the sewage of the village of Aldenville; and it will serve for the disposal of the sewage and a part of the storm water from the portion of Willimansett for which it is designed.

An additional application was received from the mayor of Chicopee, Aug. 2, 1900, for advice relative to the enlargement of the

sewer mentioned in the foregoing application, and also in regard to a proposed change in the outlet. The Board replied to this application as follows: —

Sept. 6, 1900.

The State Board of Health has considered your further application for advice with reference to the sewerage of the villages of Aldenville and Willimansett in the city of Chicopee, in which you state that you propose to enlarge the size of the main sewer from the Boston & Maine Railroad to the Connecticut River, from a maximum of two feet to five feet, in order to receive Powder Mill Brook; and that you also propose to change the outlet from Ferry Street, as proposed in the former plan, to a point opposite Call Street, about 350 feet further up stream.

The elevations of the proposed sewer and of the surface of the water in the brook at the upper end of the sewer and in the river at its lower end under different conditions are not available to the Board; but, so far as can be judged from the information available, the size of the proposed channel will probably be sufficient to carry off all the flow of the brook, together with the sewage; and, if placed at a sufficiently low level, this sewer will provide for the drainage of the land in its immediate neighborhood, and by removing the flow of Powder Mill Brook, as proposed, will relieve somewhat the flooding of the flat lands near the brook below the proposed point of diversion. It is understood that no damage to interests along the stream below will result from diverting the flow of the brook from its natural channel to a new outlet as proposed.

If the disposal of sewage by discharging it through this sewer should become objectionable from any cause, it may be desirable to divert the sewage from this sewer, and this can apparently be done without special difficulty whenever it may become necessary.

The proposed change in the place of discharge of the sewer into the Connecticut River is not objectionable, provided that provision be made, as advised in the previous reply of the Board relative to this system, for conveying the ordinary flow from the sewer to a sufficient distance from the river bank to prevent floating matters from returning and collecting upon it, and causing an odor in the vicinity of the outlet.

Concord (American Woolen Company). An application was received from the American Woolen Company, Dec. 23, 1899, for the advice of the Board relative to the disposal of the sewage of a wool-washing plant and factory sewerage system which the company proposed to construct at Concord, Mass. The Board replied to this application as follows: —

MARCH 26, 1900.

In your application you give the following description of your proposed plan: —

It is proposed to extract the fat from the water which comes from the washing of wool by some process, the nature of which is not fully decided upon as yet. In the further treatment of the wash water it is expected to employ sedimentation to remove as much as possible of the suspended matters. Septic treatment may or may not be employed, as further information shall show whether it is desirable or not.

It is proposed to pump the sewage through a cast-iron pipe line to a filtration area located on the west side of Spencer Brook in Concord, and about one-fourth mile northerly from the highway leading from Concord village to the State Reformatory and about 1,000 feet westerly from the road from Concord to Lowell. This area contains approximately 40 acres of sandy or gravelly land, most of which has a good elevation above the adjacent water courses.

It is proposed to design and construct a system of filter-beds with proper distribution system for the sewage, and collecting system or underdrains for the effluent, if such is necessary. The design is to be the result of further study of the nature of the sewage and of the material of the ground, and to meet your approval. Plans will be submitted as soon as they can be prepared.

The amount of the sewage to be treated is estimated at from 500,000 to 800,000 gallons per twenty-four hours.

Subsequently two plans were presented, one showing the area upon which it is proposed to construct the filter-beds and the other the location of this area with reference to the proposed plant at Concord Junction, and other prominent features in the vicinity. Upon receipt of these plans the Board caused the locality to be examined by one of its engineers and samples of soil from the proposed filtration area to be collected for analysis, but no further details of the proposed plan for the treatment of the wash water from the wool-scouring processes at the proposed works have been received from you by the Board.

In previous years the Board has made investigations upon the purification of wool-scouring liquors, and many samples of these liquors have been analyzed, and their character and quantity have been found to vary greatly, according to the process of scouring employed and the quality of the wool scoured. The quantity of water used in the washing or scouring of the wool at places where examinations have been made by the Board has amounted to from 1 to 2 gallons per pound of wool scoured. This liquor, upon being applied to a filter of sand, such as that which you propose to use for the purification of the wool-scouring liquor and sewage at Concord, quickly clogged the surface of the filter, on account of the excessive quantity of dirt and fats of various kinds in the wool liquor, and it was evident that the clogging matter must be removed in some other way than by filtra-

tion. After removing the fat and dirt in suspension by means of sedimentation and the use of chemicals, the supernatant liquor still contained an enormous quantity of organic matter, which was in such a state that it decomposed very slowly. When this liquid was applied to a filter in a state of active nitrification, it quickly checked and destroyed this action, and the liquid passed through the filter without material change, nor was it found practicable to purify this liquor unless it were mixed with as much as five times its volume of strong town sewage.

Samples representing all of the waste water from a wool-washing plant, including large quantities of water used in rinsing the wool after scouring, have also been examined and experiments made upon the purification of the resulting liquid. In this case the total quantity used per pound of wool was far greater than the quantity used in scouring alone, and sometimes amounted to as much as from 50 to 100 gallons per pound of wool. This total waste liquor contained much less organic matter in an equal volume than the scouring liquor alone, but still contained a very large quantity of organic matter, amounting to nearly as much as is ordinarily found in domestic sewage; but when applied to a filter of sand it was found that the organic matters were not converted into mineral matters in passing through the filter, and it was evident that the purification of this liquid also could not be effected unless it should be mixed with a considerable proportion of town sewage.

It does not seem likely that any considerable quantity of domestic sewage can be obtained to mingle with the wool-scouring liquor from the proposed works at Concord; and the investigations that have thus far been made by the Board indicate that it would probably not be practicable to purify the waste liquor from the proposed wool-scouring plant sufficiently to prevent the gross pollution of the Assabet River and the Concord River below it, even after the liquid is filtered through filters constructed upon the proposed filtration area.

Considering all the circumstances, the Board is of the opinion that it would not be advisable to construct works from which so great a quantity of wool-scouring liquor will be discharged until definite information is obtained as to a suitable method of purifying the wool liquor, and plans for purifying it at all times have been prepared. We are informed by your engineer that you do not propose to remove the fats by any process now in use in this State; if, then, you will install a plant at your Washington Mills in Lawrence, where our chemist can have convenient access, and operate it on a sufficient scale and with the variety of wools to show in a reliable way the character of the waste liquid that will result at your proposed wool-washing plant, the Board will have the effluent applied to filters and otherwise experimented with, in order to learn and to advise you as to a practicable method of purifying the waste liquor so that it may be turned into a stream without offence.

FAIRHAVEN. An application was received, April 9, 1900, from the sewer committee of Fairhaven, for the advice of the Board relative to a proposed sewerage system for a district of that town having an outlet into New Bedford harbor. The Board replied to this application as follows: —

JUNE 8, 1900.

The State Board of Health received from you, on April 9, 1900, an application for advice with reference to a proposed system of sewerage and drainage for the town of Fairhaven, accompanied by a plan showing the limits of the proposed sewer district and the proposed outlet into New Bedford harbor at the end of the tack works wharf, so called.

The district extends southerly along the harbor front from the New York, New Haven & Hartford Railroad to the limits of the thickly settled portion of the village, and extends back to a divide about 2,000 feet from the harbor front, including an area of about 140 acres. The plan shows proposed sewers in Allen and Cottage streets and in portions of Green and Fort streets, through which sewage and storm water are to be conveyed to the proposed outlet.

The Board has caused the locality to be examined by its engineer and has considered the plan and other information submitted. There would be an advantage in providing a separate system of sewerage for this district, in case, at some future time, a change in the method of disposal should be found necessary; but a system of drainage for the removal of surface and ground water from this territory is necessary at the present time, and the circumstances are such that it appears to be best to collect both sewage and storm water in the same pipes and convey it to the same outlet.

The quantity of sewage which is likely to be discharged at this outlet will be small for a long time in the future, and the outlet is so located that sewage is not likely to reach any shore of the harbor until it has become thoroughly diluted and dispersed in the sea water; and, in the opinion of the Board, the outlet is the best that it is practicable to adopt at the present time.

Another application was received, Oct. 24, 1900, from the sewer commissioners of Fairhaven, for the advice of the Board relative to the proposed construction of a sewer for a portion of that town having an outlet into the Acushnet River. The Board replied to this application as follows: —

NOV. 1, 1900.

The State Board of Health has considered your communication of October 22, requesting its advice as to the disposal of the sewage of a sewer to be constructed in Cook Street from North Main Street to the Acushnet River, to receive the sewage of Cook Street and the storm water from this

street and from portions of North and Cherry streets, and has caused the locality to be examined by its engineer.

It appears that the proposed sewer outlet is to be just beyond low-water mark in a cove near the Acushnet River, and that this cove is so shallow that the sewage cannot be discharged into a greater depth of water without carrying it a long distance from the shore. The Board is also informed that this cove is already a source of complaint in the summer season, and that floating matters deposited in New Bedford harbor tend to collect in this cove, where there is no current to carry them away. With these conditions, the discharge of sewage at this place is likely, in the opinion of the Board, to create a serious nuisance; and the Board does not advise the discharge of sewage into this cove or arm of New Bedford harbor opposite Cook Street, as indicated upon the plan submitted.

It is probable, in the opinion of the Board, that, if the outlet of the proposed Cook Street sewer could be carried further to the south, to some point opposite the end of Oxford Street or between there and the end of West Street, where deeper water can be reached at no great distance from the shore, the small quantity of sewage which this sewer will receive can be discharged into the harbor for a time without creating a serious nuisance. Sewage can be brought to this place by a pipe laid along the shore, or possibly by a sewer which would pass part of the way through private lands between North Street and Oxford Street. It is desirable, in the opinion of the Board, to keep storm water out of this sewer and to dispose of the storm water by a separate channel, since this water, if unpolluted by sewage, can be discharged into the harbor at any convenient place without creating objectionable conditions.

In the opinion of the Board, it would be of much advantage to the town, since other sewers seem likely to be required for small sections in the northerly part of the town before long, to prepare a general plan for the sewerage of those portions of the town not now provided with sewerage. When such a plan has been prepared and a suitable outlet for the sewage selected, it will be possible to build local sewers from time to time, with temporary outlets, if suitable outlets can be found, in such a manner that these sewers can form part of a general system at some future time.

GARDNER. An application was received, May 19, 1900, from the sewer commissioners of Gardner, for the advice of the Board as to the best area upon which to treat the sewage of that part of the town known as the Parker Street district, and as to the fitness of the Parker Street area for treating the sewage of the entire town, if it is desirable in the future to abandon the present location at Pond Brook, or to divert a part of the sewage from that location to the Parker Street area. The Board replied to this application as follows: —

JUNE 21, 1900.

The State Board of Health received from you, on May 19, 1900, an application for advice as to the best area on which to treat the sewage of that part of the town of Gardner known as the Parker Street district, in which you state that the results of investigations by your engineers have shown that there are two areas upon which the sewage of that district, and of the entire town also, if found desirable, can be delivered by gravity.

The plans submitted by your engineer are adapted for either filtration area, and provide for collecting the sewage in a tank, from which it will be automatically discharged through a gate-chamber upon coke strainers, from which it will pass to sand filters, and after filtration the effluent will flow into the Otter River. It is proposed to make the strainers 12 inches in thickness, the lower 6 inches being of gravel and the upper 6 inches of pieces of coke of about the size of marbles, and to operate the strainers at a rate of 1,000,000 gallons per acre per day.

The proposed filter-beds, which are to be constructed of sand or gravel, are to have a depth of 3½ feet over the underdrains and 2½ feet midway between the underdrains, which are to be 26 feet apart. Sewage from the strainers is to be applied to these filters at the rate of 150,000 gallons per acre per day.

The areas indicated for the disposal of the sewage are located about 1½ miles west of the central portion of Gardner, one being within the limits of Gardner on the north-easterly side of the Otter River, south of the main highway from Gardner to East Templeton, and the other on the opposite side of the Otter River, in the town of Templeton.

The first-mentioned area, located within the limits of Gardner, was examined by this Board last year with reference to its use for the disposal of the sewage of the Parker Street district and other portions of Gardner, and you were advised in part as follows: —

> The plan, so far as can be judged from the outlines submitted, is, in the opinion of the Board, a practicable and an appropriate one for the purification of the sewage of the thickly settled portions of the town of Gardner which are at present provided with sewers, or likely to require sewers, for many years in the future, and there does not appear to be any area containing soil suitable for this purpose which can be utilized for the disposal of all of the sewage of Gardner at less expense than the one selected.

The plan submitted at that time provided for procuring material for the construction of filters from ridges of sandy and gravelly land on the opposite side of the river in Templeton. During the present year you have secured additional legislation with reference to sewerage, and a further investigation by your engineers shows that it is feasible to convey the sewage across the river into the town of Templeton to lands which are close to

the sandy and gravelly ridges, and to construct filters there for the disposal of the sewage of the Parker Street district, and ultimately, if necessary, for the whole town, at less cost than if the works should be constructed upon the proposed area within the limits of Gardner.

The Board has caused the locality to be examined by its engineer and has carefully considered the plans and other information submitted. The Templeton area has the advantages that it is in a less exposed situation, is remote from dwellings or highways and is surrounded by woods. A long inverted siphon will be needed to convey the sewage across the valley of the Otter River; but, with the proposed provision for flushing from a large pipe of the Gardner water works, there seems to be no reason to fear any difficulty in the operation of the siphon, provided no surface water or manufacturing or other wastes which would tend to cause clogging are admitted to the sewers.

Your proposed plan of sewage disposal, as outlined in the report of your engineer, is in general adapted to the purification of the sewage which is likely to be collected from the proposed Parker Street district in the beginning in such a manner that, if the filters receive proper attention, the effluent may be discharged into the Otter River without objection. It is important that the depth of the coke strainer be not reduced materially below the depth proposed, and it is likely that less care would be required in operating the strainers and better results would be obtained by making the depth of coke in the strainers in the beginning about twice as great as proposed. The strainers should be constructed of small but well-defined pieces of coke, free from dust.

The depth of filtering material in the proposed filter beds is considerably less than would be desirable for intermittent filters operated under varying conditions at all seasons of the year, especially if the material used for the filters should be very coarse; but by the use of a coke strainer the sewage is likely to be satisfactorily purified by these filters at the rate of filtration which is proposed in your application. It is desirable to make provision, however, for increasing the depth of the filters if it shall be found desirable.

You also request advice as to the use of either of these areas for the disposal of the sewage of the other thickly settled portions of Gardner, if it is found desirable to do so in the future. The present works, as already indicated in a previous reply, are entirely inadequate for the disposal of the sewage now discharged upon them, and while by the construction of the Parker Street system it appears that a considerable portion of the sewage discharged at the present outlet will be diverted, it is nevertheless likely that enlargements of the area served by the present system and the growth of the town will soon make up for the portion which will be diverted, and it does not appear to be practicable to enlarge the present filtration area unless at a large expense.

As indicated in a previous reply, it is practicable to dispose of this sew-

age and of the sewage of the other thickly settled portions of the town in connection with the Parker Street system by gravity upon the land in Gardner near the Otter River. Your further investigations show that it is also feasible to convey this sewage by gravity to the lands which might be used for filtration in Templeton, and that an ample area of land could be made available for the purification of all of the sewage of Gardner at this place.

The Board is of the opinion that either filtration area can be made capable of disposing of all of the sewage of Gardner whenever it may be found necessary or desirable to discontinue the use of the present area and dispose of all of the sewage at one place; but, judging from the examinations and the information at present available to the Board, the area in Templeton would be less expensive to prepare and probably more satisfactory in other respects for the disposal of the sewage than the area in Gardner.

The sewer commissioners of Gardner applied to the Board, June 13, 1900, for its approval, under the provisions of chapter 64 of the Acts of 1890, as amended by chapter 212 of the Acts of 1900, of a system of sewage disposal for the town, upon a proposed area in the town of Templeton. The Board replied to this application as follows: —

JULY 5, 1900.

The State Board of Health received from you, on June 13, 1900, an application, under the authority of chapter 64 of the Acts of 1890, as amended by chapter 212 of the Acts of 1900, giving notice of your intention to introduce a system of sewerage in the town of Gardner, Mass., and submitting your proposed plans for the approval of the Board under the provisions of the above-mentioned acts.

The plans submitted, which have been adopted by your board, provide for a system of sewerage, to be built upon the so-called separate plan, for all of the thickly settled portions of the town of Gardner which are now provided with sewers or seem likely to require sewerage for many years. Two main sewers are shown on these plans, one to receive the sewage of the Parker Street district, so called, including a part of the village of West Gardner and the central village of Gardner, and the other to receive the sewage from the present sewers and from the village of South Gardner. These main sewers are to join in Coleman Street, about 500 feet west of Short Street, where the sewage will enter an inverted siphon, through which it will flow in a westerly direction across the Otter River to lands located on the westerly side of the Otter River and bordering the northerly boundary of the town of Gardner, where it is proposed to purify the sewage by intermittent filtration.

The plan for the purification of the sewage is, in its essential features, practically the same as the one submitted to the Board in May last, con-

cerning which the Board advised you in a communication dated June 21. As indicated upon the plans now before the Board, the sewage as it arrives at the filtration area is to be received in a chamber from which it will be discharged upon coke strainers, twelve in number, having an aggregate area of one and one-half acres, which are to be provided with underdrains about 6 feet apart. The strainers are to be from 10 to 14 inches in thickness, the lower portion being of broken stone or gravel and the upper 6 inches of pieces of coke of about the size of marbles. After passing through the strainers the sewage will flow upon sand and gravel filter beds, of which forty are shown upon the plan, each having an area of one-quarter of an acre. The surface of the highest of the filter beds is 7.7 feet below the surface of the coke strainer. These beds are to be provided with underdrains 26 feet apart, and the filtering material is to be 3½ feet in depth over the underdrains and 2½ feet midway between the underdrains.

The Board, having caused the locality to be examined by its engineer and considered the plans and information submitted therewith, hereby approves the system of sewerage and sewage disposal adopted and the location of lands to be taken for the purposes of sewage disposal, as required by the provisions of chapter 64 of the Acts of 1890 and chapter 212 of the Acts of 1900; the said lands to be taken, being bounded, measured and described as follows: —

Land of David Lovejoy: Beginning at a point in the centre of an old town way (now abandoned) and land of Sidney Lillie, thence N. 41¾° E. 330 feet by land of Sidney Lillie; thence N. 42½° E. 495 feet by land of Sidney Lillie and John T. Lynch; thence N. 39¾° E. 247.5 feet by land of John T. Lynch; thence N. 50½° E. 224.4 feet to land of John O'Daniels; thence S. 39½° E. 338.25 feet to Otter River; thence 60 feet to centre of Otter River; thence southerly by the centre of Otter River 1,070 feet; thence S. 72° W. 1,340 feet by land of David Lovejoy, to land of Sidney Lillie; thence N. 29¾° W. 180 feet by land of Sidney Lillie; thence S. 50° W. 202.62 feet by land of Sidney Lillie; thence N. 47½° W. 519.75 feet by land of Sidney Lillie to point of beginning.

Land of Sidney Lillie: Beginning in centre of old town way (now abandoned) and land of John T. Lynch, thence S. 41¾° W. by land of David Lovejoy 330 feet; thence S. 47½° E. 519.75 feet by land of David Lovejoy; thence N. 50° E. 202.62 feet by land of David Lovejoy; thence S. 29¾° E. 608.52 feet by land of David Lovejoy; thence S. 66¼° W. 322.6 feet by land of David Lovejoy; thence N. 54½° W. 1,500 feet by land of Sidney Lillie to land of Baker; thence N. 14° W. 370 feet by land of Baker to land of Ezra Osgood; thence N. 54¼° E. 838 feet by land of Ezra Osgood to land of John T. Lynch; thence S. 29¾° E. 690 feet by land of John T. Lynch to point of beginning.

Land of John T. Lynch: Beginning in centre of old town way (now abandoned) and at land of Sidney Lillie, thence N. 29¾° W. 390 feet by land of Sidney Lillie; thence S. 48¼° E. 285 feet by land of John T. Lynch; thence N. 42¼° E. 360 feet by land of John T. Lynch; thence N. 39¾° E. 265 feet by land of John T. Lynch; thence N. 50½° E. 250 feet by land of John T. Lynch to land of John O'Daniels and Baker; thence S. 24° E. 90 feet by land of John O'Daniels and Baker to land

of David Lovejoy and centre of old way; thence S. 50½° W. 224.4 feet by land of David Lovejoy; thence S. 39¾° W. 247.5 feet by land of David Lovejoy; thence S. 42½° E. 470 feet by land of David Lovejoy to point of beginning.

Land of John O'Daniels and Baker: Beginning at centre of old town way (now abandoned) and land of John T. Lynch, thence N. 24° W. 90 feet by land of John T. Lynch; thence N. 88½° E. 230 feet by land of John O'Daniels and Baker; thence N. 57½° E. 340 feet by land of John O'Daniels and Baker; thence N. 50° E. 200 feet by land of John O'Daniels and Baker; thence N. 77° E. 300 feet by land of John O'Daniels and Baker; thence S. 88½° E. 40 feet by land of John O'Daniels and Baker; thence S. 70½° E. 66½ feet by land of John O'Daniels and Baker to centre of Otter River; thence westerly by centre of Otter River 1,080 feet; thence westerly to the northerly river bank and land of David Lovejoy 60 feet; thence N. 39½° W. 338.25 feet by land of David Lovejoy to point of beginning.

HINGHAM. An application was received from the selectmen of Hingham, March 22, 1900, for the advice of the Board relative to the disposal of the sewage of a small summer settlement at Crow Point, so called, in Hingham, accompanied by a report of the selectmen upon the same. The Board replied to this application as follows: —

APRIL 6, 1900.

The plan in most respects appears to be the same as the plan for the disposal of the sewage of this territory which was submitted to the Board on Oct. 14, 1898, regarding which the Board advised you as follows: —

The State Board of Health received from you, on Oct. 14, 1898, an application for advice with reference to the disposal of sewage from a small summer settlement in the town of Hingham, known as Crow Point, accompanied by a plan showing the lines of the proposed sewers and the proposed location of the sewer outlet. It is understood to be a part of your plan that each house is to be provided with a cesspool, and that the sewers are to receive the overflow from these cesspools, but are not to receive storm water.

The Board has caused the locality to be examined by its engineer and has carefully considered the proposed plan. The proposed system of sewers, with such extensions as can be made, will provide for collecting sewage from nearly all of the houses on Crow Point and for the houses which may be built on high land to the west of the point.

The quantity of sewage that is likely to be discharged from the proposed system of sewers will probably be very small for several years, and it is not likely that any serious trouble will be caused by the discharge of sewage at the place proposed at all times. If the population in this region should increase considerably and a much larger number of houses should be connected with the sewers, it might be desirable to provide an outlet into the main channel; and for this reason it would be desirable to so construct the sewers that the sewage can at some future time be carried further to the east along the northerly side of Crow Point, and discharged into the main channel well out from the entrance of Hingham harbor.

With the modification suggested, the Board is of the opinion that the plan is a suitable one for the disposal of the sewage of this small portion of the town of Hingham.

By the plan now presented it appears to be the intention to discharge the sewage directly into the sewer without passing it through cesspools, as proposed in the original plan. It is not essential that the sewage be passed through cesspools before entering the sewer, and this part of the original plan can properly be omitted. There is also a provision for a check valve upon the outlet pipe, between the shore and the outlet, which is unnecessary, and it is not desirable to place anything in the pipe which might tend to form an obstruction to the flow of sewage.

After carefully considering the plan, the Board sees no reason to modify the advice already given as to the disposal of the sewage at Crow Point.

If it should happen that floating matters become noticeable in the neighborhood of the outlet in the future, trouble from this cause can be prevented by passing the sewage through a tank provided with screens, from which the floating matters can be removed from time to time as may become necessary.

HOLYOKE. An application was received from the board of public works of Holyoke, Dec. 18, 1899, for advice relative to a proposed system of sewerage for certain districts of that city, involving changes in the methods of disposal already existing. The Board replied to this application as follows: —

FEB. 3, 1900.

The State Board of Health received from you, on Dec. 18, 1899, an application for advice with reference to the disposal of the sewage from the present Walnut Street district, which is now provided with sewerage upon the combined plan and discharges into the Connecticut River just above the Holyoke dam, and with reference to a proposed new system of sewerage and sewage disposal for the Highlands district, so called, situated in the northerly part of the city of Holyoke. The application was accompanied by plans and a report by your city engineer, giving an outline of the proposed new works.

The plan for disposing of the sewage of the Walnut Street district provides for a main sewer which will intercept the dry-weather flow of sewage from the present Walnut Street sewer at a point above its outlet, and convey it in a south-easterly direction along the Boston & Maine Railroad to an existing sewer at the corner of Prospect and Union streets. From this point the sewage will flow through the sewer in Prospect Street to Front Street, and through the Front Street sewer to the Connecticut River near Springdale.

The plans for a system of sewerage for the Highlands district, so called, provide for collecting the sewage in a separate system of sewers which will discharge into a main sewer in the Dingle, so called, a ravine which enters the Connecticut River a little less than a mile above the Holyoke dam. From the Dingle a sewer will be laid down to the Boston & Maine Railroad, and along the railroad to a point of connection with the proposed main sewer, which will receive the sewage from the Walnut Street district.

The Board has caused the locality to be examined by its engineer and has considered the plans and information submitted. On account of the fact that the sewers in the Walnut Street district receive both sewage and storm water, it is not practicable to remove the entire flow from this district at all times to a suitable place of disposal at a reasonable cost; and it is necessary, for the present, at least, to allow a portion of the mingled sewage and storm water to discharge into the river at times of heavy rains.

The proposed intercepting sewer will provide for removing, in addition to the dry-weather flow of sewage from the Walnut Street sewer and the flow of sewage from the Highlands district, a small quantity of rain water, so that the first wash of the streets in heavier rains and all of the rain water in small showers or rains will be received into the intercepting sewer. In heavier rains a portion of the mingled sewage and storm water will discharge into the river at the present outlet.

The Front Street sewer, into which the proposed intercepting sewer will discharge, is of sufficient capacity to remove all of the sewage and storm water discharged into it from its present district excepting in times of extraordinary rains; and overflows have been provided, through which some of the mingled sewage and storm water from this sewer is discharged into one of the canals at such times. The discharge of the sewage from the Walnut Street and Highlands districts into this sewer will not very materially reduce its capacity for receiving storm water, and, moreover, it appears to be practicable to build a sewer which will receive a portion of the storm water of the Front Street district and prevent overflow from this sewer into the canal in the future, if it is found desirable to do so.

By adopting the separate system for the sewerage of the Highlands district, it will be practicable to remove all of the sewage from this district to a point of discharge into the Connecticut River below the city, while the storm water and drainage can be disposed of into existing natural water courses. It is desirable to separate the sewage from the storm water in the Walnut Street district, and prevent the discharge of crude sewage into the Connecticut River above the dam at any time; but by the proposed plan the estimated cost of disposing of the sewage of the Highlands and Walnut Street districts is small, and, considering all the circumstances, the plan is, in the opinion of the Board, the best method of disposing of

the sewage of those districts that it is practicable to adopt at the present time.

The present outlets of the main sewers of the city of Holyoke below the city are close to the river bank, and organic matters from the sewage are liable to collect along the bank and produce a nuisance in the summer season. The Board would advise that the ordinary flow of sewage be conveyed to a sufficient distance from the bank to prevent floating matters from returning and collecting upon it.

LONGMEADOW. An application was received from the selectmen of Longmeadow, Jan. 13, 1900, under the provisions of chapter 124 of the Acts of 1890, the substance of which was as follows: —

The undersigned, the board of selectmen of the town of Longmeadow, respectfully petition your Honorable Board for your approval, under the provisions of chapter 124 of the Acts of 1890, of our purchasing, taking or using so much as may be desirable or expedient of a certain tract of land for the disposal and purification of the sewage of said town. The said tract of land proposed to be so used is owned by Everett B. Allen, and is situated on the southerly side of the Bark Haul road in said town, contains about eleven acres and is bounded and described as follows, to wit: northerly by a town road known as the Bark Haul road, westerly by land of William C. Pease and Sumner W. Gates, southerly by land of Spencer W. Gates and Jairus R. Kibbe, and easterly by land of Jairus R. Kibbe. For a more particular description of said land reference is made to the plan accompanying this petition, which is made part of the same; and for the proposed method of the disposal of the sewage upon said lands reference is also made to the plan accompanying this petition, and also any plan heretofore filed with your Honorable Board.

The application was accompanied by a plan showing the area which it is proposed to take or use for sewage-disposal purposes, a plan of the proposed filter beds and a profile of the proposed main sewer. To this application the Board replied as follows, after a hearing had been held, as required by the provisions of the aforesaid act: —

MARCH 2, 1900.

The area which it is proposed to take for the purification of the sewage does not contain material suitable for this purpose, and it is proposed to construct two filters, each 50 feet square, of suitable sand and gravel, which is to be brought to this area from some other location. According to the proposed plans, the filters will be 5 feet in depth, consisting of gravel near the bottom and sand at the top, and will be underdrained by lines of

6-inch tile pipes laid about 6 feet apart. The plans provide for excavating the material at the location of the proposed filter beds to a sufficient depth to bring the filters to the level of the present surface of the ground.

The Board has caused the locality to be examined by its engineer and has considered plans and information submitted. The location of the proposed filtration area is remote from any dwelling house at the present time, and, if trees are planted about the filters and the area is properly cared for, the presence of the filters will not be noticeable from inhabitable lands outside of their immediate neighborhood. The proposed filters will be capable of purifying all of the sewage of the present town of Longmeadow that is included in the proposed system. There appears to be no necessity for excavating to a depth of 5 feet and constructing the filters so low that their surface will be even with the ground about them; and there will, on the other hand, be certain advantages if the filters are constructed at a higher level, since they will be less likely to become affected by freshets, and the cost of construction will be reduced. If the bottom of the filter beds is composed of coarse gravel, as proposed, the underdrains need not be nearer together than 25 feet, and a further saving in cost will be effected by leaving out unnecessary underdrainage.

In the operation of the filters it is necessary that the sewage be applied intermittently, but no provision for such application appears to have been made in the plans submitted. Intermittent application of the sewage can best be secured by means of a tank arranged to discharge the sewage automatically in considerable quantities at a time, and a suitable tank for this purpose should be provided.

The plan as a whole, with the modifications suggested, will, in the opinion of the Board, if carried out, provide satisfactorily for the purification of the sewage of the thickly settled portions of Longmeadow not now provided with sewerage.

In response to the application of the board of selectmen of the town of Longmeadow for the approval of the purchase or taking and use of a certain lot of land for the purification and disposal of sewage, the State Board of Health gave notice that a public hearing upon the matter would be given at its office on Feb. 1, 1900, under the provisions of chapter 124 of the Acts of 1890. After this hearing the State Board of Health voted to approve the purchase or taking by the town of Longmeadow, for the purification and disposal of the sewage of said town, of a certain lot of land owned by Everett B. Allen, situated on the southerly side of the Bark Haul road in said town, containing about eleven acres, as shown upon a plan entitled "Town of Longmeadow. Plan showing lot and proposed location of filter beds on same for section 2 sewers, January, 1900. Durkee, White & Towne, engineers. Scale, 1 inch = 80 feet." Said land being bounded and described as follows: —

Northerly by a town road known as the Bark Haul road, westerly by land of William C. Pease and Sumner W. Gates, southerly by land of Spencer W. Gates and Jairus R. Kibbe, and easterly by land of Jairus R. Kibbe. For a more particular description of said land reference is made to the plan accompanying this petition, which is made part of the same.

MEDFIELD INSANE ASYLUM. An application was received, June 11, 1900, from the trustees of the Medfield Insane Asylum, asking advice in regard to the best method of disposing of the sewage of the institution. The Board replied to this application as follows: —

Nov. 1, 1900.

The State Board of Health received from you, on June 11, an application requesting the advice of the Board as to a proposed change in the system of sewage disposal for the institution, and subsequently plans were received providing for diverting the sewage from the present settling tank and disposal area to a proposed filtration area situated about 2,000 feet south of the institution, and for purifying it there upon eight prepared filter beds of gravel, having an aggregate area of about two acres. The beds are to be constructed of the sand and gravel to be found at the area selected. Between the flush tank and the filter beds, at a place where the sewer passes through cultivated land, provision is to be made for diverting the sewage from the sewer for use in irrigation.

The Board has caused the locality to be examined by its engineer and has considered the plans and information submitted. The present plan of disposing of the sewage by discharging it from the settling and flush tanks into a system of pipes laid beneath the surface of the ground is unsatisfactory, the pipes and the ground around them having become so completely clogged that they will not take the sewage. Even if they should be dug up, cleaned and relaid, they would doubtless soon become clogged again. Considering all the circumstances, it seems best to abandon the use of this area.

The proposed new filter beds, if constructed throughout of the gravel and coarse sand available in the neighborhood of their location, will provide adequately for the purification of the sewage of the institution at present, and the area of the filters can be enlarged so as to dispose of a greater quantity of sewage, if necessary in the future, without special difficulty. It will probably be necessary to underdrain the filters, and provision should be made for at least one suitable underdrain through each filter bed in the beginning. If further underdrainage is found to be desirable after experience in operating the filters, it can be provided without special difficulty and at small expense. A portion of the sewage can doubtless be used to advantage in the drier portion of the year for the irri-

gation of crops, and there does not seem likely to be any objection to its use for this purpose, but it should not be used to irrigate vegetables that may be eaten uncooked.

In passing through the present settling and flush tanks the sewage doubtless decomposes and putrefies to a considerable extent, and consequently gives off a more disagreeable odor when discharged upon the filters than would be the case if the use of the tanks should be discontinued. Unless, therefore, the use of these tanks continues to be essential in removing large objects from the sewage which might otherwise clog the sewer, their use can be discontinued.

Metropolitan Sewerage Commissioners. An application was received May 2, 1900, from the Metropolitan Sewerage Commissioners, for the approval of plans for an outfall for the high-level gravity sewer, designed for the Charles and Neponset River valleys. The Board replied to this application as follows : —

May 11, 1900.

The State Board of Health received from you, on May 2, 1900, an application for the adoption and approval by the Board of plans of an outlet for the high-level gravity sewer for the relief of the Charles and Neponset River valleys, accompanied by plans and profiles of the proposed outlets.

The plans show a portion of the proposed main high-level sewer from Hough's Neck to Nut Island, the location of a sand-catcher, screens and other works on Nut Island, the location of two 60-inch pipes leading from Nut Island to outlets in the sea, and details of the proposed sand-catcher and outlets.

The Board has carefully considered the plans submitted, and finds that the outlets are the same as advised by the Board in its report to the Legislature of 1900, under the provisions of chapter 65 of the Resolves of 1899.

A note on the plan states that the works are to be constructed with or without the sand-catcher, as approved by the State Board of Health. The Board is of the opinion that the sand-catcher is a desirable provision to guard against trouble from heavier matters entering the outfall works and from deposits near the outlets.

The State Board of Health hereby adopts and approves the plans for the proposed outlets near Peddock's Island, as shown on a plan entitled "Plan showing outlet at Nut Island recommended for high-level gravity sewer, Boston, Massachusetts, May, 1900," signed by the Metropolitan Sewerage Commissioners and submitted to the State Board of Health on May 2, 1900, under the provisions of chapter 424 of the Acts of 1899; both of said outlets being located one mile from Nut Island, one directly north of the middle of the island and the other 1,500 feet east of the first.

NORTHBRIDGE (Whitinsville, the Whitin Machine Works). An application was received Sept. 13, 1900, from the Whitin Machine Works, for the advice of the Board relative to a proposed system of sewage disposal for a portion of the village of Whitinsville situated near the shore of Whitin's Pond. The Board replied to this application as follows: —

OCT. 4, 1900.

The State Board of Health received from you, on Sept. 13, 1900, an application for advice with reference to a proposed system of sewerage and sewage disposal for a section of the village of Whitinsville, situated close to the shore of Whitin's Pond, and has caused the locality to be examined by one of its engineers.

It appears that sewers have been constructed to receive the sewage discharged from the sinks of 22 houses, containing about 68 families, located near the northerly shore of Whitin's Pond, and that these sewers discharge directly into the pond at three places. It also appears that a portion of the water supply of the village of Whitinsville is drawn from a well situated on an island in Whitin's Pond, about a quarter of a mile south-east of the sewer outlets and nearer the outlet of the pond. Under the circumstances, the discharge of sewage in the manner now proposed is liable to cause serious pollution of the water drawn from the well, and injury to the health of the inhabitants of the village to whom the water may be supplied for drinking and domestic purposes, and the Board regards the proposed method of disposing of the sewage as a very objectionable one. Even if the use of the well referred to as a source of public water supply should be discontinued, the Board is of the opinion that Whitin's Pond should not be used as a place of disposal for the unpurified sewage of any portion of the village of Whitinsville, if it is possible to dispose of the sewage in some less objectionable manner.

It is understood that the subject of the sewerage of the village of Whitinsville is now under consideration by the town, and the Board is of the opinion that provision should be made, if possible, for disposing of the sewage of this territory in connection with that of the remainder of the town, and, if this is not practicable, that some other suitable method of disposal be devised.

PITTSFIELD. A communication was received, April 5, 1900, from Frank E. Pierson and others of Pittsfield, objecting to the proposed location of filter beds for sewage disposal on the south side of Pomeroy Avenue in Pittsfield, and requesting the Board to grant a hearing upon this question. The Board replied to this communication as follows: —

APRIL 11, 1900.

Your petition as citizens and residents of the city of Pittsfield, for a hearing relative to the location of sewage filter beds on the south side of Pomeroy Avenue in said city, has been received by the State Board of Health.

The subject of the disposal of the sewage of the city of Pittsfield was first brought before this Board early in the year 1888, and during that and the two following years the subject was considered by the city authorities in consultation with the State Board of Health until May 11, 1891, when a definite general plan for the sewerage and sewage disposal at Pittsfield was presented to the State Board of Health by the authorities of Pittsfield, acting under the authority of chapter 357 of the Acts of 1890. This plan provided for the disposal of the sewage upon filter beds on the south side of Pomeroy Avenue, but allowed a temporary outlet of the sewage into the east branch of the Housatonic River during construction of the sewers, but this permission was not to extend beyond the 1st of June of the present year. The general features of this plan, including the area for the disposal of the sewage, are presented upon an official plan filed in this office by the authorities of Pittsfield, and signed by John H. Manning and J. S. Bacon, commissioners of sewers of the city of Pittsfield, and approved by the State Board of Health on May 12, 1891.

In December, 1892, the sewer commissioners of Pittsfield requested the following modifications of the plan approved by the Board: —

To strike out so much of said plan as designates specific areas of land for the permanent disposition of said sewage; and by striking out so much of said plan as provides that after the date therein specified all sewage is to be pumped to filtering fields across the river and there disposed of by intermittent filtration; and by inserting instead thereof a provision that after said date all sewage is to be permanently disposed of by such methods as the State Board of Health shall then approve.

The Board replied to this application on Jan. 10, 1893, as follows: —

By the plan approved by the State Board of Health, above referred to, the Board permitted the use of the Housatonic River for the discharge of the sewage of Pittsfield until the year 1900, and after that date the sewage was to be cared for upon filtering areas of land, and the discharge into the river stopped. The use of the river was therefore but for a brief period, and the main features of the general plan presented by the city of Pittsfield, and approved by this Board, provided for the ultimate care of the sewage upon the filtering areas. The changes now asked for, if approved by this Board, would leave the city of Pittsfield without provision for its future disposal of sewage other than the river. The Board is of the opinion that such a course is not advisable for the city, nor does the Board feel it will do its duty should it approve any plan not fully providing for

the future proper sanitary care of the city's sewage. The Board therefore cannot approve the amendments as proposed, but will consider any further plans in regard to the ultimate disposal of the sewage which the city may desire to present.

The Board is informed that the location for the filter beds which is now contemplated by the city authorities is within the limits of the lands designated for filtering the sewage of the city in the plan approved by this Board in 1891. Before considering the matter, the Board desires the petitioners to state on what legal ground action can now be taken by this Board upon their aforesaid petition, in regard to the location of the sewage filtering beds of the city of Pittsfield.

No reply was made to this communication of the Board.

Pittsfield. An application was received, May 31, 1900, from the mayor of Pittsfield, requesting the advice of the Board relative to a system of sewage disposal for the city, accompanied by a statement of the proposed plan, as set forth by John N. McClintock, engineer. To this application the following reply was made.

June 11, 1900.

The State Board of Health received from you, on May 31, 1900, through John N. McClintock, civil engineer, of Boston, the following application relative to a system of sewage disposal for the city of Pittsfield: —

Acting under the authority of chapter 375 of the Acts of 1888, we hereby give notice of our intention to introduce a system of sewerage in the city of Pittsfield, and herewith submit our proposed plans for your advice as to the best practicable method of disposing of the sewage. (Signed) H. S. Russell, *Mayor.*

Reserving, without prejudice to the rights of the board of public works of Pittsfield and of other parties interested in the disposal of the sewage of the city, the consideration of the question as to whether, in the present condition of this matter, the application presented by you appears properly before the State Board of Health, the Board, having in mind the importance of prompt action on the part of the city of Pittsfield, has considered your application and presents its advice herewith.

The following outline of your proposed plans is contained in your application, viz.: —

The plan of sewage disposal to which the authorities of Pittsfield desire to call the attention of the State Board of Health, in order to obtain advice from the Board as to whether the works, if constructed, will meet the approval of said Board, and produce the required degree of purification in the sewage, before it is discharged into the river, allows for: —

1. A pumping station in the neighborhood of the present outfall sewer, so built that there may be no odor from it, providing thorough ventilation of the sewers, screen chambers, pump well and reservoir, and any other places from which an odor of sewage might escape (and, with proper care in the design and construction of the station, no odor need ever be noticed from it in the vicinity).

2. A covered reservoir at the pumping station, to receive the night flow of sewage, from which the sewage is to be pumped during working hours, to the proposed disposal area, through —

3. A thirty-inch force main; over —

4. A substantial bridge, —

5. Where it is proposed to discharge it into two or more tanks, known now as septic tanks, capable of together holding two-thirds of the daily flow of sewage, and built, covered and ventilated in the same manner as the first-mentioned receiving reservoir.

6. The flow of the sewage through the tank to be continuous except at night, when it is held in suspension.

7. The effluent to be drawn from midway of the tank, farthest from the inlet, —

8. And to be applied by a siphon discharged at intervals of one hour, more or less, upon the surface of a contact bacterial filter, of cinders or like material, which will go through a one-inch mesh but not through an eight-inch mesh: —

9. Which bacterial filter in the course of six discharges becomes thoroughly saturated, —

10. When the hourly flow of the sewage is automatically diverted on to the surface of the second bacteria bed, constructed like the first, while —

11. The first bed remains still, holding the effluent for two hours, more or less; when, —

12. By a siphon it is slowly discharged upon the surface of a coarse sand filter.

13. The bacterial filters proposed for Pittsfield occupy a space of three acres, a depth of 5 feet; and —

14. Are covered by half eighteen-inch tiles, laid as overdrains, which rest on the surface of the filters; and —

15. Are covered by gravel under the loam, —

16. And are ventilated in summer by air drawn over the filters and septic tanks, and forced artificially to the ventilating shaft in the chimney. In winter the ventilation is reversed.

17. The second filter of coarse sand is to be covered like the first filter.

18. The effluent of the coarse sand filter to be discharged directly into the river.

19. The contact bacterial filter is to be constructed of material like that in Filter No. 103 in the experimental station at Lawrence.

20. There is great opposition on the part of many influential citizens of Pittsfield to disposing of the crude sewage by discharging it upon open-air filter beds in the vicinity of the proposed disposal works, and the city will be subjected to many vexatious suits if that method is adopted.

Plans will be submitted in detail, if the above outline of the scheme meets with your approval.

Subsequent to the application, plans were submitted to the Board by you, through the same engineer, indicating the proposed method of carrying out the processes described.

The Board has carefully considered your description and the plans of works which you have submitted, and is of the opinion that works built according to the plans and description which you have submitted would not satisfactorily purify the sewage of the city of Pittsfield, and does not advise their adoption.

PITTSFIELD. An application was received, from the board of public works of Pittsfield, for the advice of the Board relative to the proposed use of a certain area of land containing about 50 acres, in the southerly part of the city, for the purpose of sewage disposal. The Board replied to this application as follows: —

AUG. 9, 1900.

The State Board of Health has considered your application for advice as to the use of a certain area of land located in the southerly part of the city of Pittsfield for the purification and disposal of the sewage of the city, and has caused the land to be examined by its engineer and samples of soil from test pits dug in various parts of this area to be analyzed.

The area of land referred to is situated on the easterly side of the Berkshire division of the New York, New Haven & Hartford Railroad, about one-half mile south of the place where the railroad crosses Lenox Middle Road, so called, and extends from the railroad to the Housatonic River. It is shown on a plan submitted by you on Aug. 8, 1900, entitled "Plan of the proposed location of filter beds, Pittsfield, Mass., Aug. 6, 1900. Scale, 1 inch = 40 feet."

The results of the examinations by the Board show that the character of the soil varies considerably in different parts of the area, consisting in the higher lands largely of very coarse gravel, and in other places of a fine sand. The coarse material is of excellent quality for the purification of sewage, and the analyses of the finer materials show that they also are well adapted to the purification of sewage.

Judging from the information available to the Board, the area as a whole is an excellent one for the purification and disposal of sewage, and is of sufficient size to provide for the purification of all of the sewage at present flowing from the city, and probably for a considerably larger quantity. It appears also that there are contiguous lands which may be made available for sewage disposal, if it should be found necessary or desirable to increase the size of the disposal works at some future time.

The cost of works for disposing of the sewage of Pittsfield upon the land

now under consideration would be somewhat greater than the cost by the plan already approved by this Board, chiefly on account of the greater distance to which the sewage would have to be conveyed; but the Board, with its present information, can see no reasonable objection to making a change in your plan of sewage disposal, so as to provide for conveying the sewage to the land now under consideration, if the city of Pittsfield so desires.

Plymouth. An application was received, Nov. 16, 1899, from the board of health of Plymouth, for the advice of the State Board of Health as to the remedy for the offensive odors from the man-holes of the sewerage system. The Board replied to this application as follows: —

June 11, 1900.

In response to your request for advice as to the remedy for offensive odors from various man-holes of the Plymouth sewerage system, the Board has caused the localities to be examined by one of its engineers. The points at which the odors appear to have been most objectionable are at the corner of Leyden and Main streets, the corner of Summer and Oak streets, and on Union Street near a lumber yard; but when visited recently, no objectionable odor was noticeable in the neighborhood of any of these man-holes. The man-hole at the corner of Leyden and Main streets, where the trouble appears to have been most serious, is located not far from the upper end of the sewer, which receives both sewage and storm water, the storm water entering through a catch-basin a short distance above the man-hole; and it appears that sand and other materials washed into the sewer tend to collect at a sharp bend in the sewer in this man-hole. While the quantity of sewage discharged into the sewer above the man-hole is small, the circumstances are such that organic matters from the sewage would collect at the bottom of the man-hole at a time when deposits of sand or other materials exist there, and putrefy, thus giving off an offensive odor, and it seems probable that such a condition has been the cause of the odors from this man-hole.

At the corner of Summer and Oak streets, where offensive odors came from the man-hole last year, a tight cover has been put in place of the perforated cover formerly in use, and danger of offensive odors from this man-hole in the future has thus been prevented.

The odor from the man-hole at Union Street, near the lumber yard, was not serious at the time the sewer was examined; but an organism sometimes found in sewers was growing quite abundantly along the sewer in this man-hole, and the conditions were favorable for the collection and decay of organic matters along the sides of the sewer.

It is probable, in the opinion of the Board, that by keeping the sewers

clean and free from deposits at the man-holes in question the odors can be materially reduced. Odors from these man-holes can be wholly prevented by providing a tight man-hole cover for each, and a ventilating pipe, about three inches in diameter, leading out of the man-hole below the cover and up the side of a neighboring building, to allow the odors to escape into the air above the roof, where they will not be noticeable.

Sheffield. The selectmen of Sheffield applied to the State Board of Health, Aug. 27, 1900, for its advice relative to the disposal of the sewage of certain buildings in Sheffield, which is discharged into a brook in that town. The Board replied to this application as follows: —

Jan. 3, 1901.

The State Board of Health has considered your application for advice as to the disposal of the sewage of the town hall in Sheffield by discharging it into Schenob Brook, and has caused the locality to be examined by one of its engineers.

It appears that sewage from several other buildings in the village is now being discharged into this brook in the neighborhood of the village, and that other portions of the village are either now in need of, or will soon require, sewerage. In the opinion of the Board, it is important for the health of the village that all sewage be kept out of Schenob and Hubbard brooks, and that the sewage of the village be collected and disposed of in some suitable manner.

The Board would advise that no new sewers be built or new connections made with any existing sewer or drain, for the purpose of disposing of any sewage, until a plan for the disposal of all of the sewage of the village has been prepared under the direction of an engineer of experience in matters relating to sewerage, in order that all sewers which may be built in the future may be made to conform to a general plan which will provide for the ultimate disposal of the sewage in a satisfactory manner.

The Board will, upon application, give you further advice in this matter when you have any plan of sewerage or sewage disposal to present.

Swampscott. An application was received, Sept. 1, 1899, from the sewer commissioners of Swampscott, for the advice of the Board relative to the disposal of the sewage of the town by discharging it into the sea at a point near Dread Ledge. A public hearing was given, in March, 1900, relative to this subject, after which the Board replied to the application as follows: —

March 5, 1900.

The State Board of Health received from you, on Sept. 1, 1899, an application for advice with reference to a proposed system of sewerage

and sewage disposal for the town of Swampscott, accompanied by a report by your engineer, Mr. F. L. Fuller, and general plans of the proposed system and outlet.

The plans provide for collecting the sewage of the central portion of the town in a reservoir just south of Humphrey Street, about 650 feet east of Marshall Street. From this reservoir the plans show a line of 18-inch cast-iron pipe passing through private land and across Orient Street, in a general south-easterly direction, to the shore of Nahant Bay, and thence beneath the waters of the bay to the neighborhood of Dread Ledge. It is proposed to pump the sewage through this main and discharge it into the sea at a point about 200 feet south of Dread Ledge and 1,500 feet from Phillip's Point, at the entrance of Nahant Bay, where the water is 40 feet deep at low tide.

It appears that the sewage from the westerly portion of the town, located in the valley of Stacy's Brook, cannot be diverted into the proposed reservoir by gravity, and the plans provide for collecting this sewage at a place near the mouth of the brook, and pumping it into a sewer which leads to the central collecting reservoir. A district in the valley of a brook at Beach Bluff, at the extreme easterly end of the town, is also situated at a low level, and it is proposed to pump the sewage from this district into the main leading to Dread Ledge.

Subsequently you submitted the results of investigations by means of floats as to the movements of the tides in the bay in the vicinity of Dread Ledge; and on March 1, 1900, after a public hearing by the State Board of Health relative to the discharge of sewage from the town of Swampscott into the sea in the neighborhood of Dread Ledge, your committee submitted the following further statement of your proposed plans: —

The committee on sewerage of the town of Swampscott agree that the floating material from the tank provided for in the system of sewerage for said town shall be disposed of otherwise than by discharge into the sea. The committee are unanimously of the opinion that the end of the discharge pipe, as located on the plan submitted to you at the hearing of this date, is the only practicable and by far the best point of discharge. We agree, however, that if, upon further investigation, another point of discharge is found to be more practicable, the committee will adopt it.

The Board has considered the plans and other information submitted and has caused the locality to be examined by its engineer. The plans for the collection of the sewage have not been presented in sufficient detail to enable the Board to advise you as to the proposed method of collecting the sewage; but it seems evident that, in order to collect the sewage at one place of disposal, it will be necessary to pump the sewage at more than one place in the town. The location of the proposed pumping station and reservoir for the central district of the town, which, according to the plan,

will receive also the sewage of the Stacy's Brook district, appears to be a satisfactory one at which to collect the sewage of those portions of the town, and these works can be so constructed that no odor will be noticeable from them in the neighborhood.

The results of the investigations by means of floats indicate that floating matters discharged at the proposed outlet would be likely to be affected in their movements very largely by the direction of the wind and very little by the direction of the tide. Judging from experience with other sewerage systems, the solid matters of the sewage will to a large extent become disintegrated during the storage of the sewage in the reservoir and its passage through the pumps and force main; and, if the quantity of sewage that is likely to be collected by the Swampscott system for many years should be discharged at this outlet, it is not probable that it could reach the shore of the mainland, or be traceable beyond a limited area in the immediate vicinity of the outlet before it would become thoroughly diluted with the sea water.

The plan of disposal of the sewage of Swampscott by discharging it into the sea, south of Dread Ledge, with the modifications contained in the statement quoted above, is, in the opinion of the Board, an appropriate method of disposing of the sewage of the town of Swampscott. When you have prepared plans of the proposed main sewers and have decided definitely upon locations for pumping stations and other works, the Board will advise you concerning them, if you so request.

You have also submitted a plan for disposing of the sewage at the various outlets by means of a system of tanks, in which the sewage will be collected and allowed to decompose, and a system of filters for the purification of effluent from the tanks. This plan of disposal of the sewage would, in the opinion of the Board, be less satisfactory for Swampscott than the discharge of the sewage into the sea, as proposed, and the disposal of the sewage of Swampscott by means of tanks and filters, as suggested, is not recommended.

Templeton (Hospital Cottages for Children). An application was received, June 7, 1899, from the trustees of the Hospital Cottages for Children at Baldwinville (Templeton), for the advice of the Board relative to a system of sewage disposal for that institution. The Board replied to this application as follows: —

Nov. 1, 1900.

The State Board of Health received from you, on June 7, 1899, an application for advice with reference to a system of sewage disposal for the Hospital Cottages for Children, and subsequently plans were received from your engineer showing the location of the proposed sewage-disposal area

and some of the details of the proposed plans. The Board then caused the locality to be examined by one of its engineers, but the results of the examination showed that the soil at the place at which it was proposed to locate the filter beds was not well adapted for the purification of sewage. Further investigations were then begun by you, but no definite location for the filter beds has yet been indicated, and no further plan for the disposal of the sewage has been presented to the Board.

The present method of disposing of the sewage is to discharge it into a ditch which flows into a brook tributary to a pond near the village of Baldwinville. The ditch and brook are rendered foul by the sewage, and this method of disposing of the sewage is, in the opinion of the Board, a very objectionable one. The Board would urge that the matter of the proper disposal of sewage for this institution be given immediate attention, and the Board will give you such assistance as it can by making such examinations of samples of soil as may be necessary, and will advise you as to any plans which you may present.

Tisbury (Vineyard Haven). An application was received, March 24, 1900, from the selectmen of Tisbury, for the advice of the Board relative to the sewage disposal of a hotel in that place. The Board replied to this application as follows: —

May 4, 1900.

The State Board of Health has considered your application for advice with reference to the disposal of the sewage of a hotel in Vineyard Haven, and has caused the locality to be examined by its engineer.

It appears that the present method of disposing of the sewage of this hotel, which is located in the densely populated part of the village, is very objectionable, and that it has been proposed to discharge it into one or more cesspools, and to allow the overflow to pass into a sewer which would conduct the sewage to the harbor; but that you fear that injury to the use of the shore of the harbor for bathing might result.

There does not appear to be any decided current in the harbor in the neighborhood of the point at which the sewage would be discharged; but, if the sewage should be collected in cesspools so arranged that they would remain full at all times, and only the overflow, drawn from the middle of the cesspool, allowed to enter the sewer, it is probable that, if the sewer outlet should be placed as much as 100 feet from the shore and about 500 feet south of the steamboat wharf, the sewage would not pollute the shore or be noticeable by bathers unless within a few feet of the outlet. The cesspools could be cleaned out when required, which would probably be at infrequent intervals, if properly constructed.

There appear to be other sections of the village of Vineyard Haven which will require sewerage before very long, and it seems likely that other

propositions for outlets into the harbor may be made. While the small amount of sewage which it is proposed to discharge into the sewer now under consideration might be discharged into the harbor without unfavorable results, there is danger that if any considerable quantity of sewage should be disposed of in this way it might become objectionable. It is also undesirable to discharge sewage into the harbor near the shores, even in small quantities; and there would be much advantage in collecting all of the sewage of the village by some general plan, and providing for its disposal in some suitable manner. With the growth of the village in the future such a system is likely to become necessary.

Considering the circumstances, the Board would advise that it is not desirable to make sewer outlets discharging into the harbor, even for small quantities of sewage, until you have had a general plan for the sewerage of the town prepared by an engineer of experience in such matters, which may ultimately provide satisfactorily for the disposal of all of the sewage. When this plan is prepared, it may be feasible to build parts of the system from time to time, as may be necessary, and temporary outlets for small quantities of sewage may possibly be made into the harbor at certain points, if found desirable, until the general system is constructed.

Wellesley College. The president of Wellesley College applied to the Board, May 18, 1900, for advice relative to a plan for "further disposal of the sewage of the college buildings." The Board replied to this application as follows: —

Nov. 1, 1900.

The State Board of Health received from you, on May 18, 1900, a request to examine the sewage-disposal systems of the college, and advise you as to a plan for further disposal of the sewage, and in response to this application the Board has caused the present systems of disposal to be examined by its engineer.

It appears that at the present time practically all of the sewage of the college is disposed of by discharging it into pipes laid with open joints beneath the surface of ground prepared for the purpose. The system which receives the greater portion of the sewage is located north-west of the college buildings, where an area of about one and one-half acres has been prepared for the purpose, near a small stream which discharges into Lake Waban. This system was first built about eight years ago, and it has been enlarged somewhat since that time. It receives the sewage of College Hall and several other buildings. The sewage first passes through settling tanks, evidently decomposing to some extent before reaching the underground pipes into which it is finally discharged. Nevertheless, the pipes have become completely clogged within about two years, and the ground about the pipes is also badly clogged with sewage, so that the sewage has

risen upon the surface of the ground and at such times gives off a very disagreeable odor.

The other principal disposal area is located at the opposite end of the college grounds, south-east of Washington Street. The quantity of sewage discharged upon this area is very much smaller than the quantity discharged at the so-called College Hall area. This system is similar to the College Hall area, and the subsurface pipes will doubtless become clogged from time to time. The other systems have been constructed generally for separate buildings, are located in different parts of the college grounds, and have also given considerable trouble.

The experience with systems of sewage disposal like that at Wellesley College, in which the sewage is discharged into pipes laid beneath the surface, has always shown that the pipes will become clogged after a time, and that it will be necessary to dig them up and relay them at quite frequent intervals. There is no doubt that there will be much saving in the cost of maintaining filters, and much smaller filters will be necessary if the sewage should be discharged upon the surface of beds of gravel or sand rather than in pipes beneath the surface; and the odor from such beds is not likely to be noticeable at any considerable distance, if the beds receive the necessary attention to keep the surfaces of the filters in good condition. They can be prevented from being unsightly, if located where they will be surrounded by trees, or if trees or shrubs are planted about them.

There is excellent gravelly land in the neighborhood of the area now used for the disposal of the sewage of College Hall, and beyond this area in a north-westerly direction from the college grounds are high gravel ridges with valleys between, containing soil well adapted to the purification of sewage by intermittent filtration. South-east of Washington Street also there appears to be land well adapted to the purification of sewage, and even the lowest ground in this neighborhood can probably be used for the purpose by spreading upon it the gravel and sand found in the higher lands near by. There would be much advantage, in the opinion of the Board, in bringing all of the sewage together to some suitable place of purification, and by applying it to open filter beds; since in this way a large saving in cost of maintaining the filters would be effected, and it would probably be easier to finally dispose of the sewage into a sewerage system of the town of Wellesley, whenever such a system may be built.

It is desirable, in providing a future system of sewerage for the college grounds, to make provision, so far as possible, for receiving the sewage of any additional buildings that may be constructed in any part of the grounds. Under the circumstances, the Board would advise that suitable surveys be made and a system of sewerage planned whereby all of the sewage may be collected at some convenient place, where it may be disposed of upon filter beds, or from which it may be pumped to some suitable place of disposal; having in view the necessity of securing a place which will dispose

of all of the sewage, if necessary, for a long time in the future, and at the same time, so planned, if possible, that connection can be made with a system that may be built by the town, without special difficulty.

When a general system of sewerage has been planned, it may be practicable to build portions of it at times as they may be needed, and thus effect a considerable saving in cost of the works. The Board will, upon application, give you further advice in this matter when you have made surveys and have further information to present.

WESTBOROUGH. The sewer commissioners of Westborough, having made certain necessary changes in the filter beds constructed for the disposal of the sewage of the town, applied to the State Board of Health, Dec. 21, 1899, for its opinion as to the efficiency of the same. The Board made the following reply: —

MARCH 6, 1900.

The State Board of Health has considered your application for advice with reference to the efficiency of the reconstructed main sewer and filter beds for the removal and purification of the sewage of the town of Westborough, and has caused the works to be examined by one of its engineers and samples of the sewage and effluent to be analyzed.

A comparison of a recent measurement of the quantity flowing in the main sewer with the quantity flowing under similar conditions last year indicates that the leakage has been very greatly reduced. The new filter beds are probably of sufficient area to purify the sewage flowing from the town under present conditions; and, when the remaining filter bed is completed, according to the plans, the filters will be of sufficient capacity to provide for a considerable increase in the quantity of sewage flowing from the town in the future, when the system becomes more generally used in the town.

The results of the analyses of the sewage and effluent show that the sewage is being efficiently purified by these filters at the present time; and, in the opinion of the Board, the filters will, if enlarged when necessary, and properly operated, purify efficiently the sewage of Westborough, so that the effluent will not have a noticeable effect upon the appearance or condition of the Assabet River.

POLLUTION OF PONDS, STREAMS AND OTHER BODIES OF WATER.

The following is the substance of the action of the Board during the past year in reply to applications for advice relative to the pollution of ponds, streams and other bodies of water: —

BRIDGEWATER. A communication was received by the Board, Nov. 1, 1900, calling its attention to the pollution of Town River

in Bridgewater by sewage. The Board caused the locality to be examined, and sent the following letter to the board of health at Bridgewater: —

JAN. 3, 1901.

The attention of the State Board of Health has been called to the pollution of the Town River in Bridgewater by a drain which discharges into that stream near the village of Bridgewater, and the Board has caused the locality to be examined by one of its engineers and a sample of the drainage to be analyzed.

It appears from this examination that there is a drain along the westerly side of the railroad in Bridgewater which discharges into the Town River, about 1,500 feet north-west of the Bridgewater railroad station. An analysis of a sample of the effluent flowing from this drain shows that it is very strong sewage, which has apparently been retained in some place of storage until it has putrefied.

The water supply of the town of Bridgewater is taken from wells near the river a short distance below the outlet of this drain, and the water supply of the State Farm is drawn directly from the river in the southerly part of the town. The discharge of unpurified sewage into the stream is contrary to law, and should be prevented.

A suitable system of sewage disposal appears to be much needed for the factories in this neighborhood, and a plan for disposing of the sewage should be provided without delay. The Board will give you such advice and assistance as it can in the selection of a suitable plan for sewage disposal, if you so request.

HAVERHILL. An application was received, May 3, 1900, for the advice of the Board relative to the liability of certain cesspools to pollute Kenoza Lake, a source of water supply of the city. The Board replied to this application as follows: —

JUNE 8, 1900.

The State Board of Health has considered your application for advice as to the method of construction of the cesspools connected with the Hale Hospital on the water-shed of Kenoza Lake, and as to the liability of the existing cesspools to pollute the water of the lake, and has caused the locality to be examined by one of its engineers. It appears that new buildings for the use of the hospital are now being constructed in another part of the city, and that within a few months the use of the present hospital buildings will be discontinued. It also appears that the proposed sewer system for the removal of sewage from the region about the westerly end of Kenoza Lake has not yet been completed, so that under the circumstances it appears to be necessary that the sewage of the hospital should be disposed of within the water-shed of the lake for a period of several months.

The present method of disposing of the sewage is to discharge it into a system of three cesspools, the sewage overflowing from the first into the second and thence into the third, and when the cesspools become full their contents are removed in carts. The cesspools are built loosely of planks with spaces between them, so that sewage can leach into the ground.

As a result of its investigations, the Board is of the opinion that the most serious dangers from the present method of disposing of the sewage are from an overflow of the cesspools and from spilling a portion of their contents upon the ground in cleaning them out.

It is not likely that danger of the pollution of the lake by unpurified sewage would be decreased by the construction of tight cesspools, since the present cesspools are so located that sewage which may filter from them into the ground is likely to become thoroughly purified before it can enter the lake.

The Board does not therefore advise any change in the construction of the cesspools, but would urge that they be cleaned out as often as is necessary to prevent danger of their contents overflowing, and that great care be taken to prevent any of the contents being discharged upon the surface of the ground when the cesspools are being cleaned out; and that, to avoid having the danger dependent upon the care of unknown future management, the sewerage system should be extended to receive this sewage as soon as practicable.

Hull and Cohasset. An application was received from E. S. Sprague and others, citizens of Hull and Cohasset, for advice in regard to the question of improving the sanitary condition of Straits Pond, lying between these towns. The Board replied to this application as follows: —

Nov. 1, 1900.

The State Board of Health has considered your petition for advice as to the improvement of the sanitary condition of Straits Pond in Hull and Cohasset, and the plans for the improvement of the pond submitted therewith, and has caused the pond and its surroundings to be examined during the past two summer seasons.

It appears from the information that has been furnished the Board, that the area overflowed by the pond was originally a salt marsh, which was later flowed and used as a reservoir for the operation of a tide mill located near the present outlet of the pond. Subsequently, the tide mill was abandoned and the pond drawn off, and apparently the area was kept free from water for a time, and crops of grass raised thereon. Later the present pond was created by a dam and tide gates in Weir River, and, while the pond has a small drainage area which supplies fresh water, the water found in the pond when examined was almost wholly sea water.

The pond has evidently been a source of complaint from time to time, on account of odors, since the growth of the region as a summer resort began, the odors being more noticeable in the latter part of the summer than at other times; but the results of the observations made by the Board have not shown that during the past two years there have been any very objectionable odors from this pond.

The pond is shallow, its general depth being only about five feet, while in some places the depth is less than two feet; and over the greater portion of the bottom there is a growth of weeds and water plants in the summer season, extending nearly to the surface of the water. The bottom is covered in most places with mud and organic matter, extending in many places to a depth of several feet, and this condition of the bottom is doubtless to a large extent the cause of the great organic growths in the water of the pond. In places where the bottom is gravelly, no such growth was found. The shores of the pond along the southerly side are quite steep, but on the northerly side they are sloping, and a small amount of fluctuation in the level of the surface of the water would expose a considerable area of the bottom. Much refuse and apparently some sewage is discharged into the pond along the northerly side; and the results of chemical analyses of the water show that, while there is much organic matter in the water in all parts of the pond, the quantity present in the water along the northerly shore is greater than in other places.

The proposed plan for improving the pond provides for introducing clean sea water into the easterly end through pipes, and for discharging water from the pond at the present outlet near its westerly end. This plan will provide for the admission of sufficient water to change the water of the pond on an average of about two or three times every month.

On account of the shallowness of the pond and the character of the bottom, its treatment in such a manner as to prevent odor from it is likely to be quite difficult. In order to effect any material improvement in the condition of the pond, it will be necessary, in the opinion of the Board, to keep all sewage and other refuse matter out of it at all times and out of the channels through which they may find their way into the pond. The mud and organic matter should be removed from the bottom about the shores from shallow places, where it is likely to be exposed by fluctuations in the level of the water. If the sewage is kept out of the pond and the shores cleaned as suggested, and clean salt water is introduced as proposed, it is likely that a considerable improvement will be effected in the condition of this pond; but the depth of the pond is so small that the proposed plan is not sure to effect a satisfactory improvement in the conditions which now cause complaint, so long as the mud and organic matter remain in its bottom.

To effect a further improvement in the character of this pond will require the removal from its entire bottom of the mud and organic matter which

now give rise to the growth of water plants and organisms. It may be practicable in the deeper parts of the pond, where the removal of the mud would be more expensive, to prevent its causing trouble by covering it with a layer of sand or gravel. If clean salt water were then introduced, as proposed, a satisfactory improvement in the condition of the pond would be effected. On account of the large area of the bottom of the pond requiring treatment, the cost of suitable improvement will be large.

Metropolitan Park Commission. A communication was received from the Metropolitan Park Commission, calling the attention of the Board to the pollution of the Charles River by the Boston Paper Company. The Board replied as follows: —

Nov. 1, 1900.

The State Board of Health received from you, on Sept. 10, a letter containing a communication from the sergeant in charge of the Charles River reservation in regard to the pollution of Charles River. The Board has caused the source of this pollution to be examined by one of its engineers, and finds that it was due to the use by the Boston Paper Company of a red earth in the process of the manufacture of paper for the purpose of giving a certain tint to the paper. The discharge of considerable quantities of this material into the river caused the discoloration of the stream for a considerable distance below the factory. The Board is informed that the coloring matter is inorganic and insoluble in water, so that it would not materially affect the sanitary condition of the river water; and the Board is further informed that the coloring was used for only a short time, and that its use has now been discontinued.

Palmer. A communication was received from D. F. Holden and others of Palmer, June 17, 1900, calling the attention of the State Board of Health to the foul condition of an open ditch or drain in that town, as follows: —

We, the undersigned, respectfully call the attention of your Honorable Board to a very obnoxious drain, running on the surface of the ground a long distance beside a highway, called Commercial Street, in the village of Palmer, from the end of a town sewer to the Quaboag River, which is considered by the following complainants as not only extremely unsightly and disgusting, but also unhealthy.

The Board replied to this communication as follows: —

July 5, 1900.

The Board has caused the locality to be examined by one of its engineers, and finds that there is a ditch running along the easterly side of Com-

mercial Street for a long distance, the bottom and sides of which are covered with sewage matters, and which gives off a very offensive odor. An analysis of a sample of the liquid flowing in this ditch shows that it is a strong town sewage.

The discharge of sewage into this ditch, in which the current is very sluggish and is much obstructed, creates, in the opinion of the Board, a very serious nuisance. The plan of sewerage for the village of Palmer presented by the authorities of the town to this Board several years ago, and concerning the adoption of which the authorities of the town were advised in a communication from this Board dated Feb. 1, 1894, provided for the disposal of all sewage of the village by discharging it into the Quaboag River below the bridge of the Boston & Albany Railroad Company until such time as the purification of the sewage should become necessary; but this plan, which is the only one relating to sewage which has been presented to this Board by the town, did not contemplate the discharge of sewage into the ditch in question, or any other local water course.

In the interest of the public health, the Board would advise the town to divert all the sewage from this ditch to some suitable place of disposal as soon as possible.

Plymouth. In accordance with the suggestion of the Board, which was made in 1899, relative to the necessity of guarding the Elder Brewster Spring from pollution and of making occasional analyses of its water, the board of health applied to the State Board of Health, June 11, 1900, for another examination of the spring. The Board replied to this application as follows: —

July 5, 1900.

In response to your request for a further examination of the Elder Brewster Spring, so called, and advice as to the quality of its water, the Board has again caused the spring and its surroundings to be examined and samples of the water to be analyzed.

The results of the examination show no material change in the conditions about the spring, and the recent analyses show no deterioration in the quality of the water over the previous year. The examinations indicate that the water of the spring is at present safe for drinking.

Westborough. A communication was received, Dec. 6, 1900, from the board of health of Westborough, relative to the condition of Chauncy Pond as a source of water supply, and as to the efficiency of the method taken by the trustees of the Lyman School to prevent the pollution of this pond by the sewage of the school. The Board replied to this communication as follows: —

Jan. 3, 1901.

The State Board of Health has considered your application for advice with reference to the condition of Chauncy Pond and the efficiency of the measures taken by the authorities of the Lyman and Industrial Schools to prevent sewage entering the pond, and has caused the locality to be examined by one of its engineers. As a result of this examination, it is found that sewage from the present disposal areas of some of the buildings of the Lyman and Industrial Schools finds its way in an unpurified state into the brook which discharges into Chauncy Pond.

In the opinion of the Board, the present systems of sewage disposal for the buildings of the Lyman and Industrial Schools within the water-shed of Chauncy Pond are not capable of efficiently purifying the sewage, and new measures which have been taken for the prevention of the pollution of the pond by the sewage have not been successful. Under the circumstances, the Board considers it unsafe to use this pond as a source of drinking water or ice supply. It is highly important that the discharge of sewage into the pond be prevented without delay if it is proposed to use this pond as a source of water or ice supply. Provision should also be made for preventing danger of pollution of the pond by sewage from other buildings within the water-shed of the pond, some of which are near its shores.

In connection with the foregoing reply, the following letter was addressed to the trustees of the Lyman and Industrial Schools: —

Jan. 3, 1901.

In response to a request from the board of health of Westborough as to the efficiency of the measures taken recently to prevent the pollution of Chauncy Pond by sewage from the Lyman and Industrial Schools, the Board has caused the locality to be examined by one of its engineers, and finds that crude sewage from some of the buildings of the Lyman School at present finds its way directly into the stream which flows into Chauncy Pond. This pond is used as a source of water supply by the Westborough Insane Hospital, and it appears that ice is taken from it in the winter season. The discharge of sewage into this source greatly endangers the health of those to whom the water or ice from Chauncy Pond may be supplied, and the Board advises that effective measures to prevent the further pollution of this pond be taken without delay.

Ice Supplies.

The following is the substance of the action of the Board during the past year in reply to applications for advice relative to sources of ice supply: —

Boston Terminal Company. An application was received, Aug. 6, 1900, for the advice of the Board relative to the quality of the ice manufactured by the company. The Board replied to this application as follows: —

Sept. 6, 1900.

In response to your request of August 6, for advice as to the quality of the ice from the ice plant of the Boston Terminal Company, the Board has caused the plant to be examined and samples of the water used and of the ice to be analyzed. It appears that in the ordinary operation of the plant, water drawn from the city mains first passes through a mechanical filter, in which alum is used as a coagulant, after which it is cooled in tanks and then passed to the freezing tanks. These are stated to be about 6 feet in depth, 20 feet in length and about 2 feet in width. Ice is formed on the sides of these tanks to a thickness of approximately 10 to 11 inches, leaving unfrozen a space of 2 to 4 inches in the middle of the tank, thus freezing at least five-sixths of the water in the tank. It also appears that the remaining water is then drawn off and filtered through a second mechanical filter with alum, and passed back with the water from the first mechanical filter into the ice tanks for another freezing, and only about once in ten weeks is the water completely drawn off and the tanks cleaned.

The results of the chemical analyses show that the water taken from the city mains is not materially changed by passing through the mechanical filter, and a considerable quantity of alum is found in this water after it is filtered.

A sample of the water collected as it was flowing to the freezing tanks was found to contain a much greater quantity of organic matter and chlorine than was present in the city water, and a much larger number of bacteria. A considerable quantity of alum was also found in the sample.

A sample of water collected from the tanks in which the ice had been frozen was found to be of very much poorer quality, and fæcal bacteria were present.

The analyses of the ice show the presence of a considerable quantity of organic matter, even in the clear ice. Part of the ice which forms first, freezes very quickly near the sides of the tanks, and in this ice, which is somewhat opaque, the quantity of organic matter found was very much larger than in the clear ice.

As a result of the examinations, the Board is of the opinion that it is necessary to make several changes in the method of operation of this plant, in order to obtain from it ice that will be safe for use in drinking water. The high chlorine of the water, while doubtless partly due to concentration by freezing, appears to be largely due to the splashing of sea water, from the pipes in which the ammonia is cooled, into the freezing tanks. As this sea water is pumped from the harbor, and is without doubt considerably

polluted, it should be prevented from finding its way into the water from which the ice is made.

The use of mechanical filters for filtering the city water used in the plant does not improve the quality of the water in any important respect, while it injures it by adding a considerable quantity of alum. The Board is of the opinion that it is not necessary to filter this water, but, if filtration or straining is deemed desirable, no alum or other chemical should be used.

It is evident that, by the rapidity with which the water is frozen, a considerable quantity of organic matter is included in the ice, and a further quantity is doubtless included on account of the large proportion of the water which is frozen. It is advisable that the ice be frozen more slowly, if possible, and it is not desirable to freeze more than two-thirds of the water in the tanks. The water remaining in the freezing tanks after the ice is frozen should all be removed, and not again discharged into the freezing tanks; and the freezing tanks should be cleaned out much more frequently than appears to be the case at present.

Concord. An application was received, Jan. 12, 1900, from Geo. G. Russell and others of Concord, for the advice of the Board relative to the use of Warner's Pond in Concord, as a source of ice supply, to which the Board replied as follows: —

March 2, 1900.

In response to your application of Jan. 12, 1900, for advice with reference to the use of Warner's Pond, in Concord, as a source of ice supply, the Board has caused the pond and its surroundings to be examined and samples of the water and ice to be analyzed.

Warner's Pond receives the flow of water from a large drainage area, which is for the most part sparsely inhabited, but the villages of South Acton and Acton are located upon the stream, though at considerable distance above the pond, and the water is exposed somewhat to pollution from factories and dwelling houses in these villages and possibly at other places. These conditions would render the pond an unsafe source from which to take ice for use in drinking waters; but it is possible to obtain ice from such a pond, that can be used with safety, by removing from the ice, after cutting, the first inch that formed upon the pond and all of that which formed above this first inch from snow or rain or flooding, and retaining for use only the clear ice, which forms under the first inch. If the ice of Warner's Pond is treated in this way the ice thus retained can, in the opinion of the Board, be safely used for domestic purposes.

Haverhill. The board of health of Haverhill applied to the State Board of Health, Jan. 18, 1900, for its advice relative to the propriety of using Lake Saltonstall as a source of ice supply for domestic use. The Board replied to this application as follows: —

FEB. 5, 1900.

The State Board of Health has considered your application for advice with reference to the use of Lake Saltonstall as a source of ice supply, and has caused the lake and its surroundings to be examined.

The waters of Lake Saltonstall have been analyzed by the Board from time to time for many years, and the results have shown that this lake receives pollution from dwelling houses on its water-shed. There is a considerable number of dwelling houses situated near the pond which are not connected with the public sewers, the sewage from which is discharged into cesspools, and there is evidence that sewage may at times find its way directly from some of these places into the lake.

Nearly all of the sewage which finds its way to the lake is probably more or less purified by passing through the ground; and, while it is not practicable to tell whether the sewage which has entered the lake during the past dry season has rendered the quality of the ice unsafe for domestic use, the analysis of a sample of ice collected by the Board from the eastern part of the lake where ice is being cut shows that its quality is not materially different from that of Round Pond, a source which is not exposed to pollution by sewage at the present time.

Under the circumstances, the Board does not consider that the ice cut at present from this source is unsafe for domestic use.

HOLYOKE. The board of health of Holyoke applied to the State Board of Health, Jan. 17, 1900, for advice relative to the matter of improving the quality of the ice sold and consumed in the city, at the same time requesting assistance "in this work by the examination of the water in the ponds, from which said ice is harvested, and in any other way that your Honorable Board may advise." Reply was made to this application as follows: —

APRIL 6, 1900.

The State Board of Health received from you, on January 17, an application for advice with reference to the sources of ice supply in Holyoke and its neigborhood from which ice is harvested for domestic purposes, and has caused examinations of these sources to be made by one of its engineers and samples of the water and ice to be analyzed.

The sources examined within the limits of Holyoke were Ashley Pond, Street's Brook, Bray's Pond, the Connecticut River and Haley Ponds. In South Hadley the following sources were examined: Buttery Brook, Jacob's Hollow Brook, Chapin Pond and Huot's Pond. Willimansett Brook in Chicopee was also examined. Ashley Pond is the source of water supply of the city of Holyoke, and the Board has already advised the city authorities as to its use as a source of ice supply.

Street's Brook, near the Northampton boundary line at the northerly end

of the city, drains a territory which is free from pollution, and the ponds on this stream are safe sources from which to take ice for domestic purposes under present conditions.

Bray's Pond, located south of the Westfield road and west of Northampton Street, evidently receives considerable polluting drainage, and the effect of this pollution is evident in the analysis of a sample of the water. The ice cut from this pond was found to contain a larger amount of organic matter than is usually present in ice from unpolluted sources, and this pond in its present state cannot be considered a safe source from which to take ice for use in connection with food or drinking water. It appears to be practicable to prevent the pollution of this source by diverting the drainage from the limited number of buildings on the water-shed away from the pond.

Ice cut from the Connecticut River does not appear to be used for domestic purposes, and would be unsafe for such use, since it is cut in the neighborhood of one of the principal sewer outlets of the city.

The Haley Ponds, located near Cherry Street, were found to be considerably polluted, and the results of examinations of the ice from these ponds show that it would be dangerous to health to use this ice in drinking water or in contact with food, and the Board would advise that the use of ice from these sources should be prevented.

Buttery Brook, in South Hadley, is used as a source of water supply for South Hadley Falls, and below the water works reservoir on this brook there are three small ponds from which ice is harvested for sale in Holyoke. The results of analyses of ice from these ponds show the presence of a larger amount of organic matter in the upper portion of the cake than is found in good ice. The ice from these sources can be safely used for domestic purposes, however, by removing from the ice, after cutting, the first inch that formed upon the ponds, and all that which formed above the first inch, from snow, rain or flooding, and using only the clear ice which formed under the first inch.

Chapin's Pond, near Newton Street, and the ponds on Jacob's Hollow Brook, appear to be free from serious danger of pollution, and the examinations indicate that these ponds are safe sources of ice supply.

Huot's Pond, located about half a mile north of Chapin's Pond and near Newton Street, derives its supply of water from a water-shed containing many houses, barns and other out-buildings, and an examination of the water shows that it is considerably polluted by sewage. It does not appear to be practicable to prevent the pollution of this source, or to obtain ice from it that can safely be used in drinking water. It is advisable, in the opinion of the Board, to prevent the use of ice from this source.

There are two sources of ice supply on Willimansett Brook in Chicopee, both being situated near the lower end of the brook. The examinations indicate that these ponds are safe sources of ice supply at present.

MANSFIELD. An application was received, Oct. 2, 1900, from the board of health of Mansfield for advice relative to the pollution of a stream in that town by sewage and manufacturing wastes, and also relative to its use as a source of ice supply. The Board replied to this application as follows: —

Nov. 1, 1900.

In response to your request of October 2, for advice as to improving the condition of the Rumford River in the town of Mansfield, which is polluted by sewage and manufacturing wastes, and as to the quality of the ice cut from the ponds on this river, the Board has caused the locality to be examined by one of its engineers and samples of the water of the river and of the ice cut from mill ponds on the stream to be analyzed.

It appears that there are five mill ponds on the Rumford River in its course through the village of Mansfield. On the main branch of the stream, which rises in Sharon, there is a very small population, and it is probable that little if any sewage finds its way directly into this stream above the first mill pond in Mansfield. The westerly branch of the stream rises in Foxborough, and receives a considerable quantity of sewage as it passes through that town. This stream discharges into the upper mill pond at Mansfield, and consequently all of the ponds in the town are polluted by sewage brought in by this stream. In addition to this pollution, a considerable quantity of sewage and manufacturing wastes is discharged directly into the stream in its course through Mansfield.

With regard to the manufacturing wastes discharged into the stream, it appears that these wastes consist very largely of acids, which are probably, under ordinary conditions, very quickly diluted so greatly with the water of the river as to be unrecognizable; but the cause of the killing of large numbers of fish in the lower ponds recently was probably the discharge of an excessive quantity of acid into the stream when the flow was very small. It appears to be possible, without special difficulty, to keep all the sewage and polluting matters out of the stream in the course of its flow through Mansfield, by providing suitable cesspools or other receptacles for the sewage until a system of sewerage is built by the town, and by providing also a suitable place or places of discharge for manufacturing wastes from the factories. Even if this should be done, the stream will still receive considerable direct sewage pollution in Foxborough, and, under the circumstances, cannot be regarded as a safe source of ice supply.

Plans for a system of sewage disposal have been prepared by the town of Foxborough, but have not yet been carried out. If it is possible to keep the Foxborough branch from polluting the upper pond in Mansfield, ice might safely be collected from this pond.

MELROSE. An application was received from the board of health of Melrose, Jan. 22, 1900, for advice relative to the use of Ell Pond

as a source of ice supply. The following reply was made by the State Board of Health: —

April 6, 1900.

The State Board of Health has considered your application for advice as to the use of ice cut from Ell Pond in Melrose for domestic purposes, and has caused examinations of the pond and its surroundings to be made and samples of the water and ice to be analyzed. This pond receives the drainage from a densely populated territory, and, while the removal of the sewage of this region is provided for by the system of sewerage of the town, it is evident that considerable polluting drainage enters the lake, which would render it an unsafe source from which to take ice for domestic purposes. Investigations which have thus far been made by the Board, however, indicate that ice cut from this lake may be safely used for domestic purposes by removing from the ice, after cutting, the first inch that formed upon the pond, and all of that which formed above this first inch by snow or rain or flooding, and retaining for use only the clear ice which forms under the first inch. The results of the examinations made by the Board indicate that, if the ice of Ell Pond is treated in this way, it may be safely used for domestic purposes.

North Adams. An application was received, June 8, 1900, from the board of health of North Adams, for advice relative to the use of the Cheshire Reservoir as a source of ice supply. The Board replied to this application as follows: —

Aug. 2, 1900.

In response to your request for advice as to whether the Cheshire Reservoir would be a safe source of ice supply, the Board has caused the reservoir and its surroundings to be examined by its engineer and has examined the results of analyses of several samples of the water.

The water-shed of this reservoir is a large one, but is very sparsely populated, excepting at the small village of Berkshire near its upper end. Careful examinations of the territory show that there is very little danger of direct pollution of the water at any place, under existing conditions. There are two small factories on opposite shores of the reservoir, near its middle, from which it is possible that some pollution might find its way into the reservoir; but such danger as there may be from these places can be readily prevented, and in any case there appears to be an ample area of reservoir above them, from which the ice can be taken, which will not be likely to receive any pollution.

The reservoir contains large numbers of stumps and considerable quantities of mud and other organic matters in its bottom, which probably have an unfavorable influence upon the appearance, taste and odor of the water, and foster organic growths and may affect the quality of the ice; but the analyses show no evidence that the water is contaminated by sewage.

The reservoir is used for the storage of water by the mills on the stream below, and is generally drawn off during the summer and fall seasons, so that the quality of the water in winter, when the reservoir has become filled again, is doubtless better than in the summer season.

While it has not been practicable since your application was made to make any analyses of ice from this reservoir, the circumstances are such that, in the opinion of the Board, this reservoir would probably be a safe source of ice supply.

North Adams. An application was received, Sept. 4, 1900, from the board of health of North Adams, for advice relative to the quality of the ice supplied by the Hygeia Ice and Cold Storage Company in that city. The Board replied to this application as follows: —

Oct. 4, 1900.

In response to your request for advice as to the quality of the ice supplied by the Hygeia Ice and Cold Storage Company of North Adams, the Board has caused the works at which the ice is made to be examined and samples of the water and of the ice to be analyzed.

It appears that, in the ordinary operation of the plant, water from the city mains is first distilled, then boiled, subsequently filtered through a filter of quartz and charcoal, and finally through a filter composed of sponges, and then passed into the freezing cans; these are stated to be 11 by 22 inches, and 44 inches in depth. The cans are then immersed in brine, and all of the water is frozen.

The water which was being supplied from the city mains at the time the examination was made contained but little organic matter and was free from odor. Analyses of samples of the ice showed the presence of a large amount of free ammonia, especially near the core of the cake, and a faint odor of phenol was found in the core. Examination of the tops of several cakes showed the presence of soapy and oily matters, which evidently find their way into the water of the tanks, but it is understood that the tops of the cakes are removed before the cakes are furnished for use.

As a result of its examinations, the Board is of the opinion that it is desirable to make several changes in the method of operating the plant, in order to obtain from it an ice that will be satisfactory for use in drinking water. It does not appear to be necessary to filter the water after distillation and boiling, though there may not be any objection to the use of a filter of clean sand. The sponge filter is not only unnecessary, but its use apparently results in adding considerable dirt and soapy matter to the water, and injuring, rather than improving, its quality before it is frozen. There is a considerable leakage of ammonia about the plant, and it is possible that to this the presence of a large quantity of free ammonia in the

ice is due, and this leakage should be prevented. The odor of the ice resembles closely the odor found in some of the rooms of the Cold Storage Company, and the two portions of the plant should be carefully separated, so that odors may not pass from the cold storage plant to the ice plant. It is also very important that care be exercised at all times to keep any matter from finding its way into the freezing cans through the cover of the freezing tank.

There are certain disadvantages in freezing all of the water which is placed in the cans, because the impurities in the water are nearly all concentrated in the last portion of the cake frozen. These impurities would be largely excluded if a portion of the water should be allowed to remain unfrozen.

It is probable that, by making the changes suggested and allowing a small portion of the water in the cake to remain unfrozen, an ice of excellent quality for use in drinking water can be obtained from this plant.

The board of health of North Adams again applied to the State Board of Health, Nov. 2, 1900, for its advice in relation to the ice manufacturing plant of the Hygeia Ice and Cold Storage Company, this company having made certain alterations in its mode of manufacture. The Board replied to the application as follows: —

Jan. 3, 1901.

In response to your application of November 2, for further advice as to the quality of the ice furnished by the Hygeia Ice and Cold Storage Company of North Adams, the Board has caused a further examination of this ice plant to be made and samples of the water and ice to be analyzed. It appears that several important changes have been made in the operation of these works since the previous advice of the Board was given, the most important being the source of water supply, which is now two large tubular wells on the grounds of the ice company, instead of from the city water supply, as formerly. The use of the sponge filter has been discontinued, and more care is evidently exercised to keep the rooms of the Cold Storage Company shut off from the place where the ice is made and to keep dirt from falling into the freezing cans.

The analysis of a sample of water collected from the wells now used as the source of water supply shows that the water is clear, colorless and odorless and almost free from organic matter; but the water is excessively hard, and has evidently been at some time highly polluted by sewage, but subsequently well purified in its passage through the ground before reaching the wells. The sample of water collected from the hose through which the freezing cans are filled after the water has been distilled, reboiled and filtered, was found, upon analysis, to be clear, colorless and odorless and

nearly free from mineral matter. The analysis showed the presence of a considerable quantity of free ammonia, which may have been due to the escape of ammonia about the plant, or perhaps to the fact that the water is not quite completely purified by the distillation. A sample of the ice frozen at this plant, sent in by you, was found upon analysis to contain considerable ammonia; but the number of bacteria present was small, and the analyses as a whole indicate that this ice as manufactured at present may safely be used for all domestic purposes.

The water from the tubular wells now used for making the ice is well purified, but its character is liable to change with a change in the conditions surrounding the wells, and for these reasons it is desirable that this water be analyzed occasionally, to detect any deterioration in its quality. The city water furnished from Notch Brook is of excellent quality, and any uncertainty as to the character of the water used in making the ice would be avoided by using the city water. The construction and arrangement of the freezing tanks makes it necessary that there should be considerable passing by workmen over the tops of the tanks; but if the present care is continued, danger of serious injury to the ice from this cause will be prevented.

Springfield. An application was received June 7, 1900, from the board of health of Springfield for the advice of the Board relative to the use of ice from the Agawam or Westfield River. The Board of Health replied to this application as follows: —

July 5, 1900.

In response to your request for advice as to the quality of ice taken from the Agawam or Westfield River for domestic purposes, the Board has caused the source to be examined by one of its engineers and samples of the ice to be analyzed.

It appears that the ice is obtained from the old bed of the Westfield River in West Springfield, about a mile above the junction with the Connecticut River; and, while the direct flow through this channel is prevented by a dam at its upper end, the water of the Westfield River backs up into it at its lower end. The river receives crude sewage from the town of Westfield and from sewers in West Springfield, and considerable pollution also from mills along the course of the stream; and analyses of samples of the ice taken from this source show that it contains a considerable quantity of organic matter. The circumstances are such that the Board does not regard the source from which this ice is taken as a safe one from which to take ice for domestic purposes, and advises that the ice collected from this source should not be used where it will come in contact with food or drinking water.

TAUNTON (H. P. Barstow). An application was received from Henry P. Barstow of East Taunton, Oct. 2, 1900, for advice relative to the use of Dean Pond as a source of ice supply. The Board replied to this application as follows: —

NOV. 1, 1900.

In response to your request of Oct. 2, 1900, for advice as to the quality of the water and ice from Dean Pond in Taunton and the best method of improving the quality of the water of the pond, the Board has caused the pond and its surroundings to be examined and samples of the water and ice to be analyzed.

The results of the examination show that the water-shed of this pond contains but little population, and the danger of direct sewage contamination of the water is small. It appears, however, that a large amount of apple pulp has in the past been discharged into the brook above the pond, and is carried down the brook and deposited in the pond near its upper end, and that there is now a considerable depth of this material on the bottom of the pond above the railroad. It also appears that the presence of this matter has affected somewhat the quality of the ice cut from the pond in past seasons, but the Board is informed that the discharge of this matter into the brook leading to the pond has now been discontinued.

If no more such material is discharged into the pond or into the stream which feeds it, the quality of the water of the pond will probably improve, and the effect of the presence of material now deposited there will become much less noticeable. It is probable, also, that this matter will not have a noticeable effect upon the quality of the ice that may be cut during the coming winter. In case it should still be noticeable, further trouble can doubtless be prevented by drawing off the pond and removing the objectionable matter, or covering it with clean gravel or sand.

WINCHESTER. An application was received, Jan. 29, 1900, from Charles E. Hemingway of Winchester, for the advice of the Board relative to the use of Wedge Pond as a source of ice supply. The Board replied to this application as follows: —

APRIL 6, 1900.

In response to your application for advice as to the use of Wedge Pond in Winchester as a source of ice supply, the Board has caused an examination of the proposed source and its surroundings to be made and samples of the water and ice to be analyzed.

Wedge Pond is fed chiefly by Horn Pond Brook, the water of which enters the pond near one end and flows out close to the place at which it enters. Horn Pond Brook receives the drainage from a densely populated area, from which considerable pollution enters the brook. While these

conditions would render the pond an unsafe source of drinking water, the circumstances are such that it is possible to obtain ice from this pond that can be used with safety by removing from the ice, after cutting, the first inch that formed upon the pond and all of that which formed above this first inch, from snow or rain or flooding, and retaining for use only the clear ice which forms under the first inch. If the ice of Wedge Pond is treated in this way, the ice thus retained can, in the opinion of the Board, be safely used for domestic purposes.

Rules and Regulations for the Purpose of preventing the Pollution and securing the Sanitary Protection of Sources of Water Supply, in Compliance with Requests from the Authorities of Cities and Towns, under the Provisions of Chapter 510 of the Acts of 1897.

Under the provisions of chapter 510 of the Acts of 1897, authorizing the State Board of Health to make rules and regulations for preventing the pollution and securing the sanitary protection of sources of water supply, requests were made during the year from the following authorities for such rules and regulations: from the Salem water board, July 13, 1900; from the mayor and aldermen of Marlborough, Oct. 15, 1900; from the water board of Norwood, Dec. 7, 1900; and copies of the rules and regulations made by the State Board of Health were forwarded to these authorities, as provided by the Act.

Examination of Water Supplies.

EXAMINATION OF WATER SUPPLIES.

EXPLANATORY NOTE.

The systematic examination of the water supplies of Massachusetts was begun by the State Board of Health June 1, 1887, and has been continued up to the present time. The results of the investigations which were made during the first two years were published in the special report of the Board upon the Examination of Water Supplies (1890), and the results of examinations made in succeeding years have been published in the annual reports of the Board beginning with the twenty-second annual report (1890).

The special report upon the Examination of Water Supplies contains descriptions of each of the water supplies in the State existing at the date of that report, and the results of chemical and microscopical examinations of samples of water collected from the principal sources of supply. The annual reports, beginning with the report for the year 1890, contain descriptions of all new works and the important changes in existing works, together with the results of the chemical and microscopical examinations which have been made of the various sources of supply.

In the annual report for the year 1898 a brief description of the sources of supply was given in cases where a knowledge of the conditions and the surroundings of the source would assist materially in understanding and interpreting the analyses. In the present report the descriptions of sources of supply have been omitted except in a few cases where the sources are new and have not previously been described.

In certain cases, where several samples from one source have been analyzed during the year, and the results of the various analyses show no marked changes, the results of the analysis of each individual sample have been omitted and only the average of the results of all the analyses of the water of this source made during the year is given.

The average analyses of former years are generally omitted, except those of sources in which there has been some very marked change in the character of the water during the period covered by the examinations.

Microscopical examinations have been made of nearly all of the samples from surface water sources which have been examined chemically. The results of these examinations have been generally omitted in this report, except in cases where certain organisms which are known to have given trouble in water supplies by causing disagreeable tastes and odors have been found in considerable numbers.

In this report, as in former reports, an alphabetical arrangement by towns has been followed, the source of supply being tabulated under the name of the town supplied, except that the description and analyses of the sources used for the supply of the Metropolitan Water District are placed at the beginning. Waters not used as sources of supply are tabulated under the name of the towns in which they are situated. The analyses of samples collected from rivers not used directly as sources of water supply are given in a subsequent chapter on the "Examination of Rivers," and the results are tabulated alphabetically by the name of the river.

The method of making the chemical examinations has not been changed during the past year. All surface waters and such samples of ground water as contain suspended matter are filtered through filter-paper before determining the color, the residue on evaporation, the albuminoid ammonia in solution and the oxygen consumed. Some ground waters which are perfectly clear and colorless when drawn from the ground become turbid and colored on standing, in consequence of the oxidation of the iron which they contain. In these waters the residue on evaporation is determined without filtration.

The color of the water is expressed by numbers, which increase with the amount of color. The standards used are natural waters, the color of which has been accurately determined by comparing them with the nesslerized ammonia standards which were described on page 531 of the special report upon the Examination of Water Supplies (1890), and on page 329 of the annual report for 1892. By using natural waters as standards for comparison, the apparent rather than the actual color is obtained, as a natural water nearly always has a greater or less turbidity, which gives the water the appearance of having a greater color than the water would have if there were no turbidity.

The rainfall during the year 1900 was a little greater than normal, but it was very unevenly distributed, — being excessive in the winter and early spring months and very light during the remainder of the year, especially in the summer months, in consequence of which the flow of streams was very small and many storage reservoirs used as sources of water supply were drawn to a low level. The ground-water level was also much lower than during an ordinary year.

Tables showing the daily rainfall at various places in the State, the average rainfall for a large number of years and the flow of some of the streams in the State, are given in a chapter entitled "Water Supply Statistics and Flow of Streams."

EXAMINATION OF WATER SUPPLIES.

Water Supply of Metropolitan Water District.

During the year 1900 water was supplied from the Metropolitan Water Works to the following cities and towns: —

City or Town.	Population in 1900.
Boston,	560,892
Somerville,	61,643
Chelsea,	34,072
Malden,	33,664
Arlington,*	8,603
Quincy,	23,899
Everett,	24,336
Medford,*	18,244
Melrose,	12,962
Watertown,	9,706
Revere,	10,395
Winthrop,	6,058
Belmont,	3,929
Nahant,	1,152
Swampscott,	4,548
Total population of cities and towns supplied,	814,103

* Partially supplied from local sources.

Water from the Nashua River has been drawn nearly every day in the year through the Wachusett Aqueduct into the Sudbury Reservoir, from which it is discharged into Framingham Reservoir No. 3 and thence sent to Chestnut Hill Reservoir and supplied to the district. After the middle of July water was drawn from the Hopkinton and Ashland reservoirs until the latter part of November. Water from Framingham Reservoir No. 2 was used for a few days in January and February and from June until December. Lake Cochituate was drawn on during February and March and from June until the end of the year.

The work of improving the bottom of Spot Pond was completed in July and the filling of the pond was begun July 12.

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water from the Quinepoxet River in Holden

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30161	Feb. 7	Slight.	Cons.	.40	3.30	1.40	.0030	.0238	.0166	.0072	.19	.0040	.0001	.61	0.6
30936	Apr. 5	V. slight.	Slight.	.36	2.80	1.00	.0010	.0190	.0162	.0028	.15	.0020	.0002	.52	0.3
31788	June 19	Slight.	Cons.	.50	3.55	1.60	.0014	.0290	.0222	.0068	.17	.0070	.0002	.63	0.5
32565	Aug. 18	Decided.	Cons.	.68	4.65	1.75	.0100	.0340	.0260	.0080	.25	.0020	.0004	.79	0.6
33171	Oct. 2	V. slight.	Slight.	.50	4.80	1.95	.0020	.0318	.0268	.0050	.28	.0020	.0002	.69	0.3
33950	Dec. 3	V. slight.	Slight.	.62	4.20	1.75	.0044	.0284	.0266	.0018	.23	.0110	.0001	.82	1.0

Averages by Years.

-	1892	-	-	.62	3.70	1.49	.0014	.0194	.0158	.0036	.19	.0088	.0001	-	0.9
-	1894	-	-	.61	3.85	1.47	.0041	.0214	.0171	.0043	.29	.0027	.0001	.58	0.7
-	1895	-	-	.77	4.47	1.97	.0020	.0289	.0239	.0050	.26	.0090	.0003	.78	0.9
-	1896	-	-	.64	3.74	1.67	.0012	.0250	.0210	.0040	.19	.0045	.0000	.71	0.4
-	1897	-	-	.77	3.88	1.78	.0032	.0275	.0232	.0043	.21	.0055	.0001	.73	0.8
-	1898	-	-	.62	3.47	1.55	.0030	.0248	.0215	.0033	.21	.0037	.0001	.60	0.8
-	1899	-	-	.48	3.65	1.69	.0028	.0261	.0206	.0055	.19	.0046	.0001	.60	0.5
-	1900	-	-	.51	3.88	1.57	.0036	.0277	.0224	.0053	.21	.0047	.0002	.68	0.5

NOTE to analyses of 1900: Odor of the first four samples, faintly vegetable, becoming stronger on heating; of the fifth, faintly unpleasant, becoming stronger on heating; of the last, none, becoming faintly vegetable on heating.——The samples were collected from the river, at Smith's Woolen Mill in Holden, and 1,000 feet above the boundary line between Holden and West Boylston. This river is one of the principal tributaries of the South Branch of the Nashua River, above the point from which the metropolitan water supply is drawn.

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water from Stillwater River in Sterling.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30162	Feb. 7	V. slight.	V. slight.	.30	2.05	1.00	.0016	.0134	.0116	.0018	.11	.0030	.0000	.53	0.5
30935	Apr. 5	V. slight.	V. slight.	.32	2.65	1.00	.0018	.0164	.0148	.0016	.14	.0010	.0002	.62	0.3
31789	June 19	V. slight.	Slight.	.42	3.35	1.55	.0012	.0168	.0144	.0024	.13	.0020	.0002	.54	0.3
32566	Aug. 18	V. slight.	V. slight.	.35	3.30	1.30	.0070	.0208	.0188	.0020	.16	.0020	.0000	.56	0.5
33170	Oct. 2	None.	Slight.	.22	2.95	1.25	.0014	.0128	.0116	.0012	.16	.0000	.0001	.32	0.8
33951	Dec. 3	None.	V. slight.	.39	4.15	1.60	.0022	.0136	.0132	.0004	.23	.0070	.0000	.63	1.6

Averages by Years.

-	1892	-	-	.44	3.38	1.18	.0001	.0131	.0109	.0022	.13	.0072	.0000	-	0.9
-	1894	-	-	.45	3.20	1.14	.0008	.0137	.0115	.0022	.18	.0017	.0000	.44	0.8
-	1895	-	-	.52	3.48	1.45	.0008	.0179	.0161	.0018	.19	.0051	.0000	.58	0.9
-	1896	-	-	.50	3.32	1.35	.0016	.0229	.0203	.0026	.16	.0035	.0000	.62	0.7
-	1897	-	-	.66	3.47	1.58	.0013	.0199	.0182	.0017	.17	.0037	.0000	.67	0.8
-	1898	-	-	.51	3.02	1.31	.0008	.0158	.0142	.0016	.16	.0026	.0001	.50	0.8
-	1899	-	-	.31	3.24	1.28	.0020	.0177	.0154	.0023	.17	.0050	.0000	.44	0.5
-	1900	-	-	.33	3.07	1.28	.0025	.0156	.0140	.0016	.15	.0025	.0001	.53	0.7

NOTE to analyses of 1900: Odor, generally none, becoming faintly vegetable on heating. A distinctly musty odor was observed in the sample collected in October.——The samples were collected from the river, at a highway bridge about one mile above the boundary line between Sterling and West Boylston. The river is one of the principal tributaries of the South Branch of the Nashua River, above the point from which the metropolitan water supply is drawn.

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water from the South Branch of the Nashua River above Clinton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29836	Jan. 1	Slight.	V. slight.	.34	4.50	1.30	.0012	.0222	.0202	.0020	.28	.0060	.0000	.54	1.7
30077	Jan. 31	Decided.	Slight.	.34	3.75	1.60	.0004	.0186	.0174	.0012	.20	.0060	.0001	.56	0.6
30302	Feb. 23	Decided.	Cons.	.32	2.85	1.15	.0032	.0180	.0166	.0014	.14	.0020	.0001	.47	0.5
30897	Apr. 2	Slight.	Slight.	.24	2.65	0.85	.0002	.0160	.0130	.0030	.14	.0050	.0001	.40	0.8
31136	Apr. 30	Slight.	Cons.	.35	3.20	1.20	.0002	.0156	.0128	.0028	.16	.0010	.0001	.50	0.8
31442	June 4	Decided.	Cons.	.35	3.55	1.15	.0030	.0172	.0142	.0030	.19	.0060	.0001	.50	0.8
31934	July 2	Slight.	Slight.	.35	4.60	1.00	.0024	.0204	.0162	.0042	.19	.0040	.0001	.47	0.8
32322	July 31	Slight.	Slight.	.26	3.85	1.20	.0010	.0234	.0192	.0042	.18	.0020	.0001	.46	1.0
32819	Sept. 4	Slight.	Cons.	.20	3.65	1.05	.0016	.0134	.0112	.0022	.23	.0030	.0000	.26	1.0
33153	Oct. 1	Slight.	Slight.	.23	3.75	0.95	.0036	.0136	.0118	.0018	.22	.0030	.0001	.25	1.3
33582	Nov. 5	Slight.	Slight.	.30	4.20	1.30	.0022	.0220	.0188	.0032	.31	.0030	.0001	.38	1.1
33900	Dec. 3	Slight.	V. slight.	.56	4.20	1.40	.0014	.0206	.0190	.0016	.23	.0020	.0000	.81	1.0

Averages by Years.

-	1894	-	-	.44	3.81	1.27	.0014	.0154	.0123	.0031	.25	.0042	.0000	.42	1.1
-	1895	-	-	.46	4.00	1.44	.0017	.0226	.0189	.0037	.26	.0090	.0000	.53	1.3
-	1896	-	-	.43	3.56	1.37	.0023	.0199	.0167	.0032	.18	.0045	.0000	.49	1.2
-	1897	-	-	.47	3.81	1.39	.0015	.0177	.0149	.0028	.21	.0057	.0000	.47	1.1
-	1898	-	-	.49	3.53	1.54	.0013	.0178	.0156	.0022	.20	.0052	.0000	.51	1.0
-	1899	-	-	.30	3.65	1.34	.0016	.0189	.0161	.0028	.20	.0053	.0001	.40	0.9
-	1900	-	-	.32	3.73	1.18	.0017	.0184	.0159	.0025	.21	.0036	.0001	.47	0.9

NOTE to analyses of 1900: Odor, faintly vegetable or none. A faintly unpleasant odor was observed in the samples collected in July and December. An unpleasant odor was developed in several of the samples on heating. —— The samples were collected from the river, at the place where water is diverted into the Wachusett Aqueduct, leading to Sudbury Reservoir, for use in supplying the Metropolitan Water District.

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water from Walker's Brook, Marlborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
29834	Jan. 1	Decided.	Cons.	–	23.00	5.60	.1800	.0530	.0460	.0070	2.57	.2120	.0036	1.42	7.1
30083	Jan. 31	Decided.	Cons.	.70	13.15	4.30	.1520	.0400	.0320	.0080	1.30	.0550	.0015	0.90	4.3
30350	Feb. 28	Decided.	Slight.	.40	16.15	4.90	.2680	.0330	.0295	.0035	1.80	.3000	.0024	0.66	5.3
30892	Apr. 2	Slight.	Slight.	.36	13.40	3.85	.1856	.0248	.0220	.0028	1.50	.2360	.0028	0.49	4.7
31123	Apr. 30	Decided.	Cons.	.41	13.85	3.65	.1104	.0296	.0252	.0044	1.64	.1720	.0036	0.61	5.0
31437	June 4	Decided.	Heavy.	–	13.75	2.10	.0580	.0780	.0340	.0440	1.33	.1080	.0060	0.84	4.4
31927	July 2	Decided.	Cons.	.42	23.40	8.75	.0290	.0790	.0400	.0390	2.35	.0820	.0120	0.73	6.3
32319	July 31	Decided.	Heavy.	.70	18.65	4.10	.0020	.0810	.0370	.0440	2.38	.0500	.0090	0.93	5.6
32804	Sept. 4	Decided.	Heavy.	.41	16.40	2.75	.0300	.0860	.0608	.0252	2.19	.0040	.0004	0.69	5.3
33146	Oct. 1	Decided.	Cons.	.42	16.80	3.55	.0080	.0584	.0372	.0212	2.03	.0510	.0050	0.67	5.3
33579	Nov. 5	Decided.	Cons.	.30	22.25	4.70	.0388	.0560	.0284	.0276	3.10	.1060	.0050	0.40	8.0
33884	Dec. 3	Decided.	Heavy.	.70	21.85	5.80	.1500	.0450	.0400	.0050	2.01	.3800	.0034	0.84	7.7

Averages by Years.

–	1892	–	–	.49	16.84	4.35	.0307	.0274	.0225	.0048	2.58	.2975	.0037	–	5.7
–	1893	–	–	.38	14.05	3.94	.0337	.0257	.0180	.0077	1.96	.1878	.0020	0.39	5.2
–	1894	–	–	.46	14.14	3.62	.0371	.0217	.0171	.0046	2.08	.1888	.0018	0.47	4.9
–	1895	–	–	.57	14.71	3.79	.0292	.0256	.0214	.0042	2.04	.1768	.0035	0.58	5.1
–	1896	–	–	.63	14.58	3.97	.0435	.0290	.0236	.0054	1.99	.1576	.0043	0.68	5.0
–	1897	–	–	.72	14.70	4.20	.0679	.0268	.0245	.0023	2.01	.1544	.0055	0.68	5.6
–	1898	–	–	.58	14.53	4.43	.0569	.0230	.0206	.0024	1.71	.2068	.0046	0.56	5.1
–	1899	–	–	.50	14.87	3.85	.0719	.0518	.0330	.0188	1.80	.1248	.0046	0.62	4.8
–	1900	–	–	.48	17.72	4.50	.1010	.0553	.0360	.0193	2.02	.1463	.0046	0.76	5.7

NOTE to analyses of 1900: Odor, unpleasant or disagreeable. —— The samples were collected from the brook at the first road bridge below Maple Street, about 1 mile south of the centre of the city of Marlborough. This brook is one of the tributaries of Stony Brook, above the Sudbury Reservoir. The water is filtered before it is discharged into the reservoir.

METROPOLITAN WATER DISTRICT.

Chemical Examination of Effluent from the Walker's Brook Filter Beds, Marlborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1900.												
29835	Jan. 1	None.	V. slight.	.00	9.00	.0036	.0046	1.16	.1320	.0015	.06	3.5	.0060
30084	Jan. 31	V. slight.	V. slight.	.07	8.60	.0162	.0048	1.35	.1220	.0007	.12	2.6	.0930
30351	Feb. 28	V. slight.	V. slight.	.10	5.80	.0152	.0036	0.83	.0740	.0001	.09	2.6	.0290
30893	Apr. 2	None.	V. slight.	.02	8.70	.0320	.0070	1.28	.1960	.0004	.10	3.0	.0330
31124	Apr. 30	None.	V. slight.	.00	10.80	.0272	.0062	1.39	.2700	.0012	.10	3.3	.0020
31438	June 4	None.	V. slight.	.01	10.00	.0062	.0078	1.34	.3000	.0006	.11	4.0	.0080
31928	July 2	None.	V. slight.	.00	9.90	.0060	.0118	1.34	.2040	.0002	.08	3.9	.0110
32320	July 31	None.	None.	.00	11.20	.0002	.0034	1.24	.1550	.0001	.10	3.6	.0030
32805	Sept. 4	None.	Slight.	.01	13.40	.0006	.0082	2.05	.0440	.0000	.13	5.1	.0040
33147	Oct. 1	None.	V. slight.	.04	16.50	.0006	.0086	1.89	.1100	.0005	.12	6.0	.0050
33580	Nov. 5	None.	V. slight.	.06	15.50	.0006	.0076	2.05	.0760	.0000	.09	5.4	.0090
33885	Dec. 3	None.	None.	.01	16.10	.0064	.0120	1.80	.5100	.0007	.09	6.3	.0040
Av...	....	....	....	.03	11.29	.0096	.0071	1.48	.1827	.0005	.10	4.1	.0172

Odor, generally none, occasionally unpleasant.—The samples represent the effluent from the filter beds which, at the time the samples were collected, were receiving water from Walker's Brook.

Chemical Examination of Water from Sudbury Reservoir, collected near the Surface.

[Parts per 100,000.]

Date of Collection.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
1900.												
January, .	.27	4.47	1.40	.0015	.0159	.0135	.0024	.27	.0047	.0001	.40	1.3
February, .	.38	3.92	1.57	.0040	.0225	.0189	.0036	.20	.0080	.0001	.58	1.0
March, . .	.34	3.49	1.29	.0094	.0189	.0158	.0031	.18	.0088	.0001	.50	0.9
April, . .	.22	3.10	1.05	.0041	.0160	.0132	.0028	.18	.0085	.0002	.37	0.9
May, . .	.22	3.28	1.09	.0038	.0157	.0130	.0027	.20	.0082	.0001	.36	0.9
June, . .	.24	3.47	1.16	.0021	.0187	.0163	.0024	.21	.0042	.0001	.40	1.0
July, . .	.20	3.49	1.14	.0015	.0175	.0142	.0033	.20	.0007	.0001	.39	1.0
August, . .	.12	3.27	1.03	.0009	.0173	.0145	.0028	.20	.0006	.0000	.36	1.1
September, .	.11	3.36	0.95	.0007	.0175	.0143	.0032	.22	.0020	.0000	.30	1.1
October, .	.12	3.53	1.00	.0017	.0166	.0143	.0023	.24	.0024	.0000	.26	1.3
November, .	.14	3.72	1.01	.0028	.0154	.0131	.0023	.26	.0020	.0001	.28	1.3
December, .	.34	4.30	1.26	.0032	.0174	.0152	.0022	.25	.0152	.0001	.51	1.5
Average, .	.22	3.62	1.16	.0030	.0175	.0147	.0028	.22	.0054	.0001	.39	1.1

Odor, faintly vegetable or none, occasionally unpleasant.—Each analysis is the average of analyses of samples collected weekly from the reservoir, near the gate-house, at a depth of 1 foot beneath the surface. For monthly record of height of water in this reservoir, see table on page 128.

METROPOLITAN WATER DISTRICT.

*Microscopical Examination of Water from Sudbury Reservoir, collected near the Surface.**

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
PLANTS.												
Diatomaceæ,	31	6	16	371	319	93	290	301	635	423	702	318
Asterionella,	18	2	11	333	203	8	9	14	24	45	300	173
Cyclotella,	2	1	1	0	1	81	140	62	21	1	4	1
Melosira,	0	0	0	0	38	0	8	7	50	26	114	14
Synedra,	4	1	1	20	49	1	4	4	12	15	57	63
Tabellaria,	3	2	2	17	28	3	127	214	528	336	226	67
Cyanophyceæ,	0	0	0	0	0	5	4	2	1	10	5	0
Anabæna,	0	0	0	0	0	3	2	1	0	10	5	0
Algæ,	0	1	0	11	34	123	69	66	45	2	8	2
Protococcus,	0	1	0	11	31	108	66	61	39	0	3	0
ANIMALS.												
Infusoria,	27	24	34	45	2	1	2	7	7	5	5	2
Dinobryon,	26	16	16	23	14	0	2	2	3	0	1	0
Euglena,	0	2	6	13	1	0	0	0	0	0	0	0
Peridinium,	1	4	11	5	0	0	0	4	2	1	0	0
Vermes,	0	0	1	1	0	0	0	0	1	0	0	0
Crustacea, Cyclops,	pr.	pr.	0	pr.	pr.	pr.	pr.	pr.	pr.	pr.	pr.	pr.
Miscellaneous, Zoöglœa,	4	9	8	7	5	4	6	5	5	6	6	5
TOTAL,	62	40	59	435	360	226	371	381	694	446	726	327

* The figures given in this table are the averages of weekly examinations.

Chemical Examination of Water from Sudbury Reservoir, collected about Midway between the Surface and Bottom.

[Parts per 100,000.]

Date of Collection.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
1900.												
January,	.26	4.51	1.44	.0014	.0145	.0127	.0018	.28	.0050	.0001	.39	1.3
February,	.35	4.06	1.46	.0044	.0196	.0170	.0026	.22	.0112	.0001	.54	1.0
March,	.35	3.50	1.27	.0093	.0178	.0155	.0023	.18	.0096	.0002	.50	0.9
April,	.23	3.11	1.07	.0039	.0147	.0119	.0028	.17	.0072	.0001	.37	0.8
May,	.21	3.25	1.05	.0032	.0145	.0123	.0022	.20	.0078	.0001	.36	0.9
June,	.23	3.47	1.11	.0053	.0160	.0144	.0016	.20	.0052	.0002	.40	0.9
July,	.20	3.44	1.14	.0036	.0160	.0134	.0026	.20	.0012	.0001	.37	1.0
August,	.13	3.28	1.06	.0024	.0157	.0136	.0021	.21	.0008	.0000	.36	1.1
September,	.10	3.36	0.94	.0007	.0163	.0131	.0032	.22	.0012	.0000	.31	1.2
October,	.11	3.49	0.99	.0021	.0160	.0137	.0023	.23	.0020	.0000	.26	1.4
November,	.14	3.69	1.00	.0027	.0152	.0129	.0023	.26	.0032	.0001	.29	1.4
December,	.35	4.32	1.25	.0034	.0178	.0154	.0024	.25	.0147	.0000	.51	1.5
Average,	.22	3.62	1.15	.0035	.0162	.0138	.0024	.22	.0058	.0001	.39	1.1

Odor, faintly vegetable or none, occasionally unpleasant. A vegetable or unpleasant odor was developed in all of the samples on heating.—— Each analysis is the average of analyses of samples collected weekly from the reservoir, near the gate-house, at depths ranging from 17 to 27 feet beneath the surface. For monthly record of height of water in this reservoir, see table on page 128.

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water from Sudbury Reservoir, collected near the Bottom.

[Parts per 100,000.]

Date of Collection.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
1900.												
January,	.24	4.47	1.40	.0020	.0144	.0131	.0013	.28	.0055	.0001	.38	1.3
February,	.34	4.26	1.49	.0041	.0181	.0166	.0015	.22	.0112	.0001	.51	1.0
March,	.34	3.57	1.28	.0088	.0178	.0156	.0022	.18	.0094	.0002	.49	0.9
April,	.23	3.16	1.07	.0042	.0143	.0120	.0023	.18	.0067	.0001	.37	0.8
May,	.21	3.34	1.00	.0034	.0142	.0120	.0022	.19	.0088	.0001	.36	0.8
June,	.23	3.48	1.14	.0063	.0143	.0132	.0011	.20	.0065	.0002	.39	0.9
July,	.20	3.44	1.18	.0050	.0151	.0130	.0021	.20	.0015	.0001	.37	1.0
August,	.14	3.46	1.17	.0040	.0155	.0133	.0022	.21	.0008	.0000	.36	1.1
September,	.11	3.36	0.92	.0019	.0163	.0135	.0028	.22	.0012	.0000	.30	1.1
October,	.13	3.52	0.97	.0028	.0159	.0133	.0026	.24	.0026	.0000	.27	1.3
November,	.14	3.71	0.99	.0028	.0158	.0134	.0024	.26	.0025	.0001	.30	1.3
December,	.34	4.34	1.23	.0032	.0178	.0155	.0023	.25	.0137	.0001	.52	1.6
Average,	.22	3.68	1.15	.0040	.0158	.0137	.0021	.22	.0059	.0001	.38	1.1

Odor, faintly vegetable or none, occasionally unpleasant. A vegetable or unpleasant odor was developed in all of the samples on heating. —— Each analysis is the average of analyses of samples collected weekly from the reservoir, near the gate-house. For monthly record of height of water in this reservoir, see table on page 128.

Chemical Examination of Water from Framingham Reservoir No. 3.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29821	Jan. 1	Slight.	Slight.	.30	4.35	1.35	.0026	.0144	.0130	.0014	.28	.0040	.0001	.38	1.6
30074	Jan. 31	Decided.	Slight.	.23	4.65	1.50	.0028	.0156	.0134	.0022	.26	.0060	.0001	.38	2.0
30336	Feb. 28	Decided.	Cons.	.37	3.95	1.35	.0042	.0220	.0172	.0048	.21	.0100	.0002	.56	1.0
30894	Apr. 2	Decided.	Cons.	.28	3.45	1.15	.0066	.0142	.0130	.0012	.19	.0070	.0001	.43	1.0
31127	Apr. 30	Slight.	Cons.	.17	3.25	1.15	.0002	.0170	.0132	.0038	.27	.0050	.0000	.35	0.8
31432	June 4	V. slight.	Cons.	.21	3.55	0.95	.0022	.0164	.0140	.0024	.22	.0050	.0001	.36	1.1
31911	July 2	V. slight.	Slight.	.17	3.15	0.90	.0012	.0166	.0126	.0040	.20	.0030	.0001	.35	1.1
32309	July 31	V. slight.	V. slight.	.12	3.25	1.00	.0002	.0186	.0138	.0048	.24	.0010	.0000	.41	1.0
32786	Sept. 4	V. slight.	Slight.	.10	3.25	1.05	.0002	.0170	.0144	.0026	.21	.0010	.0000	.30	1.0
33134	Oct. 1	Slight.	Slight.	.12	3.65	1.15	.0008	.0172	.0148	.0024	.22	.0010	.0000	.29	1.4
33560	Nov. 5	V. slight.	Slight.	.10	3.35	1.15	.0024	.0180	.0150	.0030	.26	.0000	.0000	.26	1.3
33887	Dec. 3	Slight.	Cons.	.11	3.75	0.90	.0028	.0162	.0132	.0030	.26	.0020	.0001	.29	1.6
Av...	....	....	....	.19	3.63	1.13	.0022	.0170	.0140	.0030	.23	.0037	.0001	.36	1.2

Odor, faintly vegetable or none. A vegetable odor was developed in all of the samples on heating. —— The samples were collected from the reservoir, near the gate-house, at a depth of 8 feet beneath the surface. For monthly record of height of water in this reservoir, see table on page 128.

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water from Indian Brook, at Head of Hopkinton Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29826	Jan. 1	V. slight.	V. slight.	0.95	8.90	3.55	.0014	.0288	.0260	.0028	.64	.0010	.0001	1.48	2.6
30341	Feb. 28	Slight.	V. slight.	0.90	3.55	1.95	.0010	.0192	.0180	.0012	.21	.0010	.0001	1.04	1.1
31131	Apr. 30	V. slight.	V. slight.	1.45	3.90	1.90	.0010	.0330	.0314	.0016	.29	.0030	.0000	1.72	1.3
31915	July 2	V. slight.	V. slight.	1.20	5.15	2.40	.0032	.0344	.0332	.0012	.27	.0010	.0000	1.33	1.0
32798	Sept. 4	Decided.	Cons.	0.42	3.50	1.40	.0046	.0272	.0216	.0056	.29	.0010	.0000	0.65	0.6
33565	Nov. 5	Decided.	Cons.	1.10	8.90	3.65	.0028	.0468	.0394	.0074	.64	.0010	.0000	1.55	2.3
Av...	....	....	....	1.00	5.65	2.47	.0023	.0316	.0283	.0033	.39	.0013	.0000	1.29	1.5

Odor, faintly vegetable or none. A vegetable odor was developed in all of the samples on heating. —— The samples were collected from the brook, at its entrance to Hopkinton Reservoir.

Chemical Examination of Water from Hopkinton Reservoir, collected near the Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29827	Jan. 1	V. slight.	Slight.	.30	3.70	1.20	.0008	.0190	.0166	.0024	.37	.0010	.0001	.44	1.4
30342	Feb. 28	Decided.	Slight.	.44	3.85	1.65	.0046	.0212	.0182	.0030	.25	.0050	.0002	.67	0.6
31132	Apr. 30	Slight.	Cons.	.45	3.30	1.45	.0008	.0240	.0184	.0056	.25	.0010	.0000	.60	0.6
31916	July 2	V. slight.	Slight.	.51	3.10	1.20	.0008	.0204	.0170	.0034	.23	.0000	.0000	.70	0.8
32799	Sept. 4	Slight.	Slight.	.36	3.10	1.35	.0028	.0232	.0196	.0036	.28	.0010	.0001	.62	0.5
33566	Nov. 5	V. slight.	Slight.	.33	3.15	1.25	.0060	.0182	.0166	.0016	.28	.0000	.0000	.49	0.8

Averages by Years.

-	1894	-	-	.79	3.93	1.59	.0013	.0191	.0166	.0025	.40	.0040	.0001	.75	1.2
-	1895	-	-	.73	4.15	1.86	.0017	.0239	.0210	.0029	.40	.0048	.0000	.76	1.3
-	1896	-	-	.64	3.86	1.74	.0017	.0208	.0175	.0033	.32	.0040	.0001	.71	0.9
-	1897	-	-	.76	4.18	1.85	.0019	.0221	.0198	.0023	.37	.0059	.0001	.75	1.1
-	1898	-	-	.62	3.71	1.80	.0016	.0204	.0183	.0021	.35	.0030	.0000	.69	1.1
-	1899	-	-	.36	3.31	1.55	.0011	.0178	.0160	.0018	.28	.0041	.0000	.50	0.8
-	1900	-	-	.40	3.37	1.35	.0026	.0210	.0177	.0033	.28	.0013	.0001	.59	0.8

NOTE to analyses of 1900: Odor, none. A faintly vegetable odor was developed in all of the samples on heating. —— The samples were collected from the reservoir, near the dam. For monthly record of height of water in this reservoir, see table on page 128.

METROPOLITAN WATER DISTRICT.

Microscopical Examination of Water from Hopkinton Reservoir, collected near the Surface.

[Number of organisms per cubic centimeter.]

	1900. Jan.	Mar.	May.	July.	Sept.	Nov.
Day of examination,	2	1	1	3	5	6
Number of sample,	29827	30342	31132	31916	32799	33566
PLANTS.						
Diatomaceæ,	40	14	3,400	157	61	421
Asterionella,	26	11	3,216	25	27	328
Tabellaria,	14	0	160	128	16	93
Cyanophyceæ,	0	0	4	4	0	1
Algæ,	0	0	160	596	109	7
Protococcus,	0	0	160	586	99	0
ANIMALS.						
Infusoria,	1,068	6	72	4	70	1
Dinobryon,	1,048	3	72	0	63	1
Uroglena,	20	0	0	0	0	0
Vermes,	0	1	2	0	0	0
Miscellaneous, Zoöglœa,	0	5	10	3	6	10
TOTAL,	1,108	26	3,648	764	246	440

Chemical Examination of Water from Hopkinton Reservoir, collected near the Bottom.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
29828	Jan. 1	V. slight.	Slight.	.30	3.55	1.35	.0010	.0176	.0164	.0012	.30	.0010	.0002	.41	0.8
30343	Feb. 28	Decided.	Slight.	.46	3.95	1.80	.0046	.0198	.0180	.0018	.27	.0060	.0002	.66	0.8
31133	Apr. 30	Slight.	Cons.	.43	3.35	1.45	.0006	.0194	.0156	.0038	.25	.0030	.0000	.60	0.6
31917	July 2	V. slight.	Slight.	.42	3.15	1.10	.0078	.0172	.0140	.0032	.23	.0020	.0000	.60	0.6
32800	Sept. 4	Decided.	Cons.	.60	3.35	1.35	.0160	.0200	.0156	.0044	.27	.0010	.0001	.56	0.6
33567	Nov. 5	V. slight.	Slight.	.34	3.05	1.30	.0050	.0190	.0176	.0014	.28	.0020	.0000	.53	0.6

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water, from Hopkinton Reservoir, collected near the Bottom — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
-	1895	-	-	.75	4.33	1.94	.0036	.0204	.0181	.0023	.41	.0064	.0001	.77	1.3
-	1896	-	-	.63	3.82	1.75	.0013	.0189	.0164	.0025	.35	.0050	.0001	.71	0.9
-	1897	-	-	.71	4.06	1.72	.0020	.0188	.0173	.0015	.37	.0078	.0001	.73	1.1
-	1898	-	-	.62	3.74	1.70	.0022	.0168	.0156	.0012	.35	.0057	.0000	.65	1.0
-	1899	-	-	.37	3.27	1.43	.0022	.0163	.0141	.0022	.28	.0054	.0000	.50	0.7
-	1900	-	-	.42	3.40	1.39	.0058	.0188	.0162	.0026	.27	.0025	.0001	.56	0.7

NOTE to analyses of 1900: Odor of No. 32800, very faintly unpleasant; of the others, none, becoming generally faintly vegetable on heating. —— The samples were collected from the reservoir, near the dam. For monthly record of height of water in this reservoir, see table on page 128.

Chemical Examination of Water from Cold Spring Brook, at Head of Ashland Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29823	Jan. 1	V. slight.	V. slight.	1.24	8.90	3.95	.0008	.0378	.0352	.0026	.39	.0010	.0000	1.66	2.6
30338	Feb. 28	Slight.	Slight.	0.95	3.75	2.20	.0004	.0254	.0232	.0022	.23	.0050	.0001	1.00	0.6
31128	Apr. 30	V. slight.	Slight.	1.40	5.50	3.15	.0012	.0392	.0380	.0012	.28	.0010	.0000	1.38	0.8
31912	July 2	V. slight.	Slight.	1.46	4.90	2.60	.0012	.0348	.0344	.0004	.23	.0010	.0000	1.32	0.8
32795	Sept. 4	V. slight.	V. slight.	0.23	3.10	1.00	.0012	.0144	.0130	.0014	.28	.0040	.0001	0.31	0.5
33561	Nov. 5	None.	V. slight.	0.78	6.40	2.90	.0018	.0304	.0280	.0024	.37	.0020	.0000	1.08	1.8
Av...	....	....	....	1.01	5.42	2.63	.0011	.0303	.0286	.0017	.30	.0023	.0000	1.12	1.2

Odor, vegetable. —— The samples were collected from the brook, at its entrance into Ashland Reservoir.

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water from Ashland Reservoir, collected near the Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
29824	Jan. 1	V. slight.	Slight.	.41	4.05	1.65	.0010	.0212	.0194	.0018	.27	.0010	.0001	.52	1.0
30339	Feb. 28	Decided.	Cons.	.57	3.40	1.75	.0012	.0246	.0212	.0034	.22	.0050	.0004	.78	0.6
31129	Apr. 30	V. slight.	Slight.	.50	3.40	1.00	.0010	.0188	.0170	.0018	.21	.0040	.0000	.70	0.8
31913	July 2	Slight.	Slight.	.59	3.70	1.85	.0014	.0210	.0200	.0010	.20	.0010	.0000	.75	0.6
32796	Sept. 4	V. slight.	Slight.	.43	3.15	1.25	.0012	.0228	.0204	.0024	.22	.0010	.0000	.65	0.5
33562	Nov. 5	None.	V. slight.	.35	3.10	1.40	.0018	.0188	.0180	.0008	.24	.0010	.0000	.55	0.6

Averages by Years.

-	1888	-	-	.72	3.83	1.70	.0007	.0277	-	-	.22	.0054	.0001	-	-
-	1889	-	-	.85	3.48	1.50	.0016	.0251	.0218	.0033	.23	.0068	.0002	-	-
-	1890	-	-	.61	3.67	1.40	.0008	.0222	.0191	.0031	.24	.0096	.0001	-	1.7
-	1891	-	-	.53	3.24	1.55	.0006	.0187	.0156	.0031	.20	.0062	.0001	-	0.9
-	1892	-	-	.64	3.60	1.52	.0002	.0200	.0168	.0032	.23	.0061	.0001	-	1.1
-	1893	-	-	.77	3.54	1.63	.0024	.0206	.0173	.0033	.23	.0048	.0001	.68	1.0
-	1894	-	-	.83	4.00	1.73	.0027	.0202	.0180	.0022	.29	.0045	.0001	.78	1.1
-	1895	-	-	.89	4.22	2.04	.0015	.0246	.0223	.0023	.32	.0052	.0000	.90	1.1
-	1896	-	-	.75	3.90	1.86	.0008	.0239	.0210	.0029	.27	.0024	.0000	.91	0.9
-	1897	-	-	.84	4.07	1.81	.0017	.0242	.0224	.0018	.31	.0027	.0000	.79	1.1
-	1898	-	-	.72	3.76	1.85	.0008	.0221	.0205	.0016	.29	.0032	.0000	.75	1.0
-	1899	-	-	.41	3.12	1.45	.0007	.0189	.0168	.0021	.23	.0028	.0000	.53	0.6
-	1900	-	-	.47	3.47	1.48	.0013	.0212	.0193	.0019	.23	.0022	.0001	.66	0.7

NOTE to analyses of 1900: Odor, faintly vegetable or none. —— The samples were collected from the reservoir, near the gate-house. For monthly record of height of water in this reservoir, see table on page 128.

METROPOLITAN WATER DISTRICT.

Microscopical Examination of Water from Ashland Reservoir, collected near the Surface.

[Number of organisms per cubic centimeter.]

	1900.					
	Jan.	Mar.	May.	July.	Sept.	Nov.
Day of examination,	2	1	1	2	5	6
Number of sample,	29824	30339	31129	31913	32796	33562
PLANTS.						
Diatomaceæ,	**14**	**12**	**20**	**219**	**40**	**45**
Cyclotella,	0	1	2	194	23	1
Algæ,	**95**	**0**	**629**	**52**	**66**	**3**
Protococcus,	93	0	628	36	66	3
ANIMALS.						
Infusoria,	**18**	**1**	**3**	**5**	**21**	**2**
Dinobryon,	11	1	2	3	11	0
Crustacea, Cyclops,	**0**	**0**	**0**	**0**	**pr.**	**0**
Miscellaneous, Zoöglœa,	**5**	**5**	**3**	**3**	**3**	**5**
TOTAL,	132	18	655	279	130	55

Chemical Examination of Water from Ashland Reservoir, collected near the Bottom.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29825	Jan. 1	V. slight.	Slight.	.34	3.65	1.15	.0006	.0182	.0164	.0018	.24	.0010	.0001	.43	1.3
30340	Feb. 28	Decided.	Cons.	.55	3.70	1.80	.0018	.0244	.0224	.0020	.22	.0050	.0001	.76	0.8
31130	Apr. 30	V. slight.	Slight.	.50	3.20	1.25	.0012	.0184	.0176	.0008	.22	.0030	.0000	.70	0.8
31914	July 2	V. slight.	Slight.	.58	3.00	1.00	.0062	.0186	.0180	.0006	.21	.0090	.0000	.73	0.6
32797	Sept. 4	V. slight.	Slight.	.46	3.05	1.25	.0022	.0208	.0186	.0022	.22	.0020	.0000	.64	0.5
33563	Nov. 5	None.	Slight.	.40	3.00	1.50	.0022	.0186	.0180	.0006	.24	.0020	.0000	.60	0.8

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water from Ashland Reservoir, collected near the Bottom — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
-	1888	-	-	.72	4.02	1.70	.0025	.0261	-	-	.23	.0059	.0001	-	-
-	1889	-	-	.86	3.55	1.49	.0023	.0224	.0198	.0026	.22	.0086	.0002	-	-
-	1890	-	-	.66	3.97	1.54	.0017	.0199	.0168	.0031	.23	.0120	.0001	-	1.6
-	1896	-	-	.73	4.07	1.89	.0012	.0213	.0186	.0027	.26	.0039	.0000	.88	1.0
-	1897	-	-	.86	4.30	1.94	.0022	.0223	.0207	.0016	.31	.0047	.0001	.78	1.2
-	1898	-	-	.69	3.84	1.87	.0015	.0203	.0191	.0012	.29	.0037	.0001	.73	1.0
-	1899	-	-	.43	3.07	1.39	.0014	.0160	.0148	.0012	.24	.0042	.0000	.52	0.6
-	1900	-	-	.47	3.27	1.32	.0024	.0198	.0185	.0013	.22	.0037	.0000	.64	0.8

NOTE to analyses of 1900: Odor, faintly vegetable or none. A vegetable odor was developed in all of the samples on heating. —— The samples were collected from the reservoir, near the gate-house. For monthly record of height of water in this reservoir, see table on page 128.

Chemical Examination of Water from Sudbury River, at Head of Framingham Reservoir No. 2.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29819	Jan. 1	V. slight.	V. slight.	0.55	6.30	2.30	.0030	.0202	.0190	.0012	.43	.0010	.0001	0.68	2.0
30334	Feb. 28	Slight.	V. slight.	0.65	3.95	1.65	.0006	.0210	.0198	.0012	.25	.0100	.0002	0.79	0.6
31125	Apr. 30	V. slight.	Slight.	1.05	4.15	2.20	.0006	.0290	.0252	.0038	.25	.0040	.0000	1.13	0.8
31909	July 2	V. slight.	Slight.	0.95	4.90	2.05	.0046	.0336	.0296	.0040	.26	.0030	.0001	0.88	1.1
32784	Sept. 4	Slight.	Cons.	0.44	3.90	1.30	.0008	.0210	.0192	.0018	.29	.0040	.0000	0.55	0.8
33558	Nov. 5	V. slight.	Slight.	0.70	3.55	1.75	.0018	.0270	.0252	.0018	.26	.0060	.0000	0.84	0.3
Av...	....	....	....	0.72	4.46	1.87	.0019	.0253	.0230	.0023	.29	.0047	.0001	0.81	0.9

Odor, faintly vegetable, becoming stronger on heating. —— The samples were collected from the river, near the old dam at the upper end of Framingham Reservoir No. 2, at a depth of 1 foot beneath the surface.

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water from Framingham Reservoir No. 2.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
29820	Jan. 1	V. slight.	Slight.	.38	4.80	1.55	.0008	.0176	.0160	.0016	.37	.0010	.0000	0.49	0.8
30335	Feb. 28	Decided.	Slight.	.59	3.40	1.50	.0010	.0206	.0184	.0022	.20	.0060	.0001	0.69	0.5
31126	Apr. 30	V. slight.	Slight.	.65	3.60	1.45	.0002	.0236	.0204	.0032	.26	.0030	.0000	0.83	0.8
31910	July 2	V. slight.	Slight.	.97	4.65	2.15	.0034	.0288	.0258	.0030	.24	.0010	.0001	1.01	1.0
32785	Sept. 4	Slight.	Slight.	.41	3.25	1.35	.0014	.0222	.0200	.0022	.29	.0010	.0000	0.57	0.6
33559	Nov. 5	V. slight.	Slight.	.44	3.45	1.55	.0024	.0204	.0190	.0014	.29	.0020	.0000	0.62	0.8

Averages by Years.

-	1888	-	-	1.08	4.63	2.01	.0005	.0300	-	-	.30	.0102	.0001	-	-
-	1889	-	-	1.04	3.42	1.26	.0015	.0296	.0252	.0044	.29	.0075	.0002	-	-
-	1890	-	-	0.77	4.58	1.83	.0010	.0235	.0191	.0044	.28	.0128	.0001	-	1.7
-	1891	-	-	0.72	4.02	1.68	.0004	.0230	.0194	.0036	.24	.0105	.0001	-	1.0
-	1892	-	-	0.89	4.35	1.92	.0004	.0231	.0192	.0039	.29	.0082	.0001	-	1.3
-	1893	-	-	0.98	4.28	1.86	.0010	.0219	.0190	.0029	.31	.0054	.0001	.81	1.2
-	1894	-	-	1.12	4.36	2.05	.0008	.0216	.0193	.0023	.33	.0058	.0000	.93	1.3
-	1895	-	-	1.03	4.65	2.05	.0015	.0244	.0211	.0033	.34	.0090	.0001	.98	1.2
-	1896	-	-	0.74	4.08	1.87	.0011	.0233	.0200	.0033	.30	.0051	.0001	.84	0.9
-	1897	-	-	0.96	4.53	2.04	.0013	.0252	.0229	.0023	.32	.0087	.0001	.89	1.1
-	1898	-	-	0.89	4.47	2.19	.0022	.0241	.0220	.0021	.29	.0054	.0001	.93	1.1
-	1899	-	-	0.40	3.39	1.48	.0006	.0194	.0173	.0021	.26	.0046	.0000	.53	0.7
-	1900	-	-	0.57	3.86	1.59	.0015	.0222	.0199	.0023	.27	.0023	.0000	.70	0.7

NOTE to analyses of 1900: Odor, faintly vegetable.——The samples were collected from the reservoir, near the gate-house, at a depth of 8 feet beneath the surface. For monthly record of height of water in this reservoir, see table on page 128.

METROPOLITAN WATER DISTRICT.

Microscopical Examination of Water from Framingham Reservoir No. 2.

[Number of organisms per cubic centimeter.]

	1900.					
	Jan.	Mar.	May.	July.	Sept.	Nov.
Day of examination,	2	1	1	2	4	6
Number of sample,	29820	30335	31126	31910	32785	33559
PLANTS.						
Diatomaceæ,	58	7	162	60	11	45
Asterionella,	32	1	107	1	0	28
Cyclotella,	12	0	0	58	10	1
Cyanophyceæ,	0	0	0	1	8	0
Algæ,	16	0	86	46	70	0
Protococcus,	16	0	86	42	66	0
ANIMALS.						
Infusoria,	92	27	4	2	5	0
Dinobryon,	90	25	0	0	0	0
Vermes,	0	0	3	0	0	0
Crustacea, Cyclops,	0	0	0	0	0	pr.
Miscellaneous, Zoöglœa,	7	5	7	5	5	7
TOTAL,	173	39	262	114	99	52

Chemical Examination of Water from Lake Cochituate in Wayland.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
29822	Jan. 1	Slight.	Slight.	.19	5.15	1.95	.0014	.0308	.0272	.0036	.53	.0050	.0001	.40	2.0
30075	Jan. 31	V. slight.	Slight.	.14	4.55	1.80	.0014	.0146	.0142	.0004	.38	.0060	.0001	.34	1.7
30337	Feb. 28	V. slight.	Slight.	.19	4.20	1.35	.0024	.0176	.0144	.0032	.36	.0050	.0002	.33	1.7
30902	Apr. 2	V. slight.	Slight.	.13	4.15	1.15	.0032	.0196	.0176	.0020	.43	.0060	.0001	.36	1.7
31117	Apr. 30	V. slight.	Cons.	.13	4.35	1.15	.0006	.0226	.0192	.0034	.42	.0030	.0001	.42	1.7
31431	June 4	V. slight.	Slight.	.20	4.45	1.50	.0032	.0230	.0200	.0030	.44	.0010	.0001	.37	1.7
31922	July 2	V. slight.	Cons.	.12	4.40	1.15	.0020	.0212	.0170	.0042	.43	.0000	.0002	.40	2.0
32310	July 31	V. slight.	Slight.	.09	4.65	1.55	.0004	.0254	.0198	.0056	.39	.0000	.0000	.42	1.7
32790	Sept. 4	V. slight.	Cons.	.10	4.60	1.25	.0016	.0232	.0186	.0046	.44	.0020	.0000	.36	1.6
33135	Oct. 1	V. slight.	Cons.	.11	4.75	1.55	.0036	.0264	.0196	.0068	.42	.0010	.0000	.38	2.1
33568	Nov. 5	V. slight.	Slight.	.11	4.50	1.35	.0036	.0192	.0168	.0024	.47	.0020	.0001	.31	1.8
33886	Dec. 3	V. slight.	Cons.	.21	4.70	1.30	.0160	.0226	.0196	.0030	.44	.0010	.0003	.33	2.3

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water from Lake Cochituate in Wayland — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
-	1888	-	-	.19	4.90	1.24	.0033	.0217	-	-	.43	.0127	.0003	-	-
-	1889	-	-	.33	5.08	1.62	.0025	.0210	.0177	.0033	.46	.0208	.0003	-	-
-	1890	-	-	.21	4.74	1.03	.0016	.0184	.0149	.0035	.49	.0206	.0003	-	2.4
-	1891	-	-	.24	4.66	1.44	.0017	.0182	.0145	.0037	.42	.0212	.0002	-	1.8
-	1892	-	-	.15	4.61	1.35	.0018	.0168	.0133	.0035	.48	.0152	.0001	-	2.0
-	1893	-	-	.21	4.64	1.58	.0015	.0168	.0138	.0030	.46	.0098	.0002	.39	2.0
-	1894	-	-	.20	4.76	1.59	.0008	.0163	.0137	.0026	.51	.0070	.0001	.37	2.1
-	1895	-	-	.25	5.08	1.68	.0015	.0178	.0153	.0025	.51	.0112	.0001	.42	2.1
-	1896	-	-	.28	4.89	1.65	.0012	.0176	.0145	.0031	.50	.0122	.0001	.45	1.9
-	1897	-	-	.31	5.11	1.73	.0012	.0202	.0172	.0030	.52	.0092	.0001	.44	2.1
-	1898	-	-	.30	4.92	1.79	.0016	.0203	.0173	.0030	.47	.0066	.0001	.45	2.1
-	1899	-	-	.22	4.74	1.68	.0020	.0232	.0193	.0039	.43	.0090	.0001	.43	1.7
-	1900	-	-	.14	4.54	1.42	.0033	.0222	.0187	.0035	.43	.0027	.0001	.37	1.8

NOTE to analyses of 1900: Odor, faintly vegetable or none. A vegetable and occasionally an unpleasant odor was developed in some of the samples on heating. —— The samples were collected from the gate-house. For monthly record of height of water in this lake, see table on page 128.

Microscopical Examination of Water from Lake Cochituate in Wayland.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	Apr.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	2	1	1	3	30	5	3	1	5	1	6	4
Number of sample,	29882	30075	30337	30902	31117	31431	31922	32310	32790	33135	33568	33886
PLANTS.												
Diatomaceæ,	**1,936**	**491**	**358**	**1,160**	**3,781**	**187**	**11**	**15**	**26**	**83**	**76**	**475**
Asterionella,	1,800	426	56	928	2,272	77	1	0	0	27	38	176
Melosira,	91	45	207	82	344	27	0	0	0	0	6	215
Synedra,	0	0	2	0	536	0	1	14	0	2	9	0
Tabellaria,	34	0	68	126	572	57	6	0	0	13	3	68
Cyanophyceæ,	**6**	**6**	**1**	**4**	**0**	**5**	**20**	**47**	**104**	**198**	**2**	**1**
Anabæna,	0	0	0	0	0	2	18	47	94	196	1	0
Algæ,	**1**	**0**	**12**	**59**	**0**	**32**	**280**	**3**	**12**	**18**	**6**	**3**
Protococcus,	0	0	12	58	0	24	275	0	12	16	0	0

METROPOLITAN WATER DISTRICT.

Microscopical Examination of Water from Lake Cochituate in Wayland — Concluded.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	Apr.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.												
Infusoria,	16	18	35	14	26	21	7	1	2	1	22	10
Dinobryon,	0	8	29	0	10	19	2	0	0	0	1	0
Mallomonas,	13	2	2	2	1	0	2	0	0	1	12	0
Vermes, Asplanchna,	1	0	0	0	0	0	0	0	0	0	0	0
Crustacea,	pr.	pr.	0	0	0	pr.	0	pr.	0	pr.	pr.	pr.
Cyclops,	pr.	pr.	0	0	0	pr.	0	0	0	pr.	pr.	pr.
Daphnia,	0	0	0	0	0	0	0	pr.	0	0	pr.	0
Miscellaneous, Zoöglœa,	5	5	5	3	5	3	5	3	3	5	5	10
TOTAL,	1,965	520	411	1,240	3,802	248	323	69	147	305	111	499

Chemical Examination of Water from the Terminal Chamber of the Sudbury Aqueduct at Chestnut Hill Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29847	Jan. 2	Slight.	V. slight.	.25	4.80	1.60	.0024	.0166	.0160	.0006	.32	.0080	.0001	.40	1.4
30145	Feb. 8	V. slight.	V. slight.	.27	4.85	1.55	.0028	.0170	.0148	.0022	.27	.0060	.0001	.48	1.4
30354	Feb. 28	Decided.	Slight.	.31	3.90	1.40	.0050	.0188	.0166	.0022	.20	.0140	.0001	.50	1.1
30904	Apr. 2	Slight.	Cons.	.30	3.25	1.10	.0064	.0144	.0130	.0014	.18	.0070	.0002	.41	1.0
31114	Apr. 30	V. slight.	Cons.	.20	3.30	1.10	.0014	.0160	.0126	.0034	.18	.0100	.0001	.36	0.8
31421	June 2	Slight.	Slight.	.22	3.30	1.00	.0024	.0168	.0146	.0022	.22	.0060	.0001	.37	1.0
31943	July 2	V. slight.	Slight.	.33	3.40	1.05	.0016	.0186	.0158	.0028	.19	.0060	.0001	.43	1.0
32351	July 31	V. slight.	Slight.	.12	3.85	1.10	.0030	.0154	.0128	.0026	.20	.0020	.0001	.39	1.0
32818	Sept. 4	V. slight.	Cons.	.20	3.35	0.95	.0020	.0164	.0138	.0026	.27	.0020	.0000	.35	1.0
33133	Oct. 1	Slight.	Slight.	.26	3.70	1.40	.0020	.0192	.0166	.0026	.24	.0040	.0001	.43	1.3
33590	Nov. 5	V. slight.	Slight.	.22	3.45	1.05	.0024	.0194	.0170	.0024	.28	.0010	.0001	.36	1.3
34102	Dec. 14	Slight.	Cons.	.29	4.75	1.65	.0026	.0160	.0136	.0024	.29	.0100	.0000	.40	1.8
Av...	....	....	....	.25	3.82	1.25	.0028	.0171	.0148	.0023	.24	.0063	.0001	.41	1.2

Odor, faintly vegetable or none. A distinctly vegetable odor was developed on heating in several of the samples collected during the latter half of the year.

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water from a Faucet at the State House, Boston.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29815	Jan. 1	Slight.	Slight.	.33	4.40	1.50	.0008	.0134	.0112	.0022	.30	.0070	.0001	.35	1.4
30078	Feb. 1	Slight.	Slight.	.25	4.70	1.50	.0010	.0136	.0120	.0016	.27	.0100	.0002	.38	1.4
30146	Feb. 9	Slight.	V. slight.	.25	4.70	1.55	.0022	.0156	.0142	.0014	.30	.0110	.0001	.41	1.4
30332	Feb. 28	Slight.	V. slight.	.28	4.20	1.55	.0020	.0172	.0148	.0024	.28	.0150	.0002	.41	1.4
30887	Apr. 2	Slight.	Slight.	.27	3.45	1.10	.0034	.0152	.0130	.0022	.17	.0080	.0001	.42	1.1
31112	Apr. 30	V. slight.	Slight.	.20	3.45	1.05	.0012	.0146	.0114	.0032	.20	.0130	.0000	.36	0.8
31423	June 4	Slight.	Slight.	.20	3.30	0.95	.0014	.0150	.0134	.0016	.21	.0100	.0001	.34	0.8
31903	July 2	V. slight.	Slight.	.24	3.45	1.05	.0004	.0138	.0126	.0012	.22	.0080	.0000	.36	1.3
32288	July 30	V. slight.	Slight.	.17	3.40	1.00	.0002	.0164	.0140	.0024	.24	.0020	.0001	.39	1.1
32844	Sept. 7	Slight.	Cons.	.21	3.50	1.10	.0002	.0174	.0154	.0020	.22	.0030	.0000	.37	1.4
33137	Oct. 1	Slight.	Cons.	.27	3.70	1.45	.0014	.0186	.0164	.0022	.23	.0050	.0000	.44	1.4
33551	Nov. 5	None.	V. slight.	.12	4.00	1.00	.0006	.0156	.0148	.0008	.39	.0050	.0000	.36	1.6
33901	Dec. 4	V. slight.	Slight.	.34	4.00	1.15	.0012	.0170	.0166	.0004	.30	.0050	.0001	.42	2.0

*Averages by Years.**

-	1888	-	-	.38	4.94	1.53	.0012	.0215	-	-	.40	.0183	.0002	-	-
-	1889	-	-	.51	4.71	1.43	.0005	.0199	.0176	.0023	.42	.0272	.0002	-	-
-	1890	-	-	.35	4.70	1.25	.0003	.0169	.0148	.0021	.42	.0241	.0001	-	2.2
-	1891	-	-	.37	4.39	1.63	.0005	.0161	.0136	.0025	.37	.0227	.0001	-	1.7
-	1892	-	-	.37	4.70	1.67	.0007	.0168	.0138	.0030	.41	.0210	.0001	-	1.9
-	1893	-	-	.61	4.54	1.84	.0010	.0174	.0147	.0027	.38	.0143	.0001	.60	1.8
-	1894	-	-	.69	4.64	1.83	.0006	.0169	.0150	.0019	.41	.0106	.0001	.63	1.7
-	1895	-	-	.72	4.90	2.02	.0006	.0197	.0175	.0022	.40	.0171	.0001	.69	0.7
-	1896	-	-	.49	4.29	1.67	.0005	.0165	.0142	.0023	.37	.0155	.0001	.56	1.4
-	1897	-	-	.65	4.82	1.84	.0009	.0193	.0177	.0016	.40	.0137	.0001	.64	1.6
-	1898	-	-	.41	4.19	1.60	.0008	.0152	.0136	.0016	.29	.0097	.0001	.44	1.4
-	1899	-	-	.23	3.70	1.30	.0006	.0136	.0122	.0014	.24	.0137	.0001	.35	1.1
-	1900†	-	-	.24	3.80	1.20	.0012	.0157	.0139	.0018	.25	.0076	.0001	.38	1.3

NOTE to analyses of 1900: Odor, faintly vegetable or none. A vegetable odor was developed in all of the samples on heating.

* Previous to 1897 these samples were collected from a faucet at the Institute of Technology. The character of the water at this place, however, does not differ materially from that of the water drawn from the faucet at the State House.

† Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water from Faucets in Revere.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29861	Jan. 1	V. slight.	Slight.	.17	3.80	1.10	.0000	.0148	.0126	.0022	.32	.0040	.0001	.33	1.4
30112	Feb. 2	V. slight.	V. slight.	.21	4.50	1.45	.0006	.0132	.0130	.0002	.30	.0100	.0002	.37	1.7
30364	Mar. 1	V. slight.	V. slight.	.25	4.20	1.35	.0010	.0130	.0124	.0006	.25	.0050	.0002	.38	1.3
30932	Apr. 5	Slight.	V. slight.	.13	5.60	1.50	.0062	.0122	.0114	.0008	.30	.0120	.0002	.30	2.1
31137	Apr. 30	V. slight.	Slight.	.12	3.15	1.10	.0014	.0152	.0122	.0030	.23	.0050	.0001	.32	1.3
31459	June 5	Slight.	Slight	.14	3.55	0.95	.0004	.0154	.0140	.0014	.22	.0070	.0000	.33	1.0
31948	July 5	V. slight.	V. slight.	.18	3.30	1.00	.0012	.0154	.0140	.0014	.26	.0060	.0001	.34	1.6
32345	Aug. 1	V. slight.	Cons.	.14	3.25	1.15	.0000	.0150	.0144	.0006	.23	.0040	.0001	.35	1.6
32822	Sept. 4	Slight.	Slight.	.14	3.65	1.00	.0006	.0154	.0138	.0016	.24	.0010	.0000	.33	1.3
33148	Oct. 1	Decided.	Slight.	.22	3.50	1.00	.0006	.0186	.0174	.0012	.24	.0020	.0001	.34	1.8
33616	Nov. 6	V. slight.	V. slight.	.19	3.55	1.15	.0018	.0160	.0154	.0006	.27	.0020	.0000	.39	1.3
33956	Dec. 5	V. slight.	V. slight.	.21	3.65	1.15	.0016	.0156	.0148	.0008	.29	.0060	.0001	.41	1.8
Av.	....	....	....	.17	3.81	1.16	.0013	.0150	.0138	.0012	.26	.0053	.0001	.35	1.5

Odor, faintly vegetable or none. —— The samples were collected from faucets in various parts of the town.

Table showing Monthly Heights, in Feet, above Mean Low Water, of the Lakes and Storage Reservoirs of the Metropolitan Water Works, from which Samples of Water were collected during the Year 1900.

	Sudbury Reservoir. Stone Crest, 259.97.	Framingham Reservoir No. 3. Stone Crest, 186.50.	Hopkinton Reservoir. Flash Boards, 305.00.	Ashland Reservoir. Flash Boards, 225.23.	Framingham Reservoir No. 2 Flash Boards, 177.12.	Lake Cochituate. High Water, 144.36.	Spot Pond. High Water, 163.00.
1900.							
Jan. 1,	245.06	184.01	280.54	195.21	175.01	139.78	144.20
Feb. 1,	245.09	183.98	284.15	199.22	177.32	141.61	145.12
March 1,	255.20	183.61	299.18	216.31	176.25	144.23	147.10
April 1,	259.29	185.16	304.24	224.46	176.15	144.12	142.85
May 1,	260.02	185.86	304.95	225.19	177.27	144.36	141.50
June 1,	260.01	186.08	305.09	225.23	177.76	144.38	141.30
July 1,	259.14	184.78	305.01	225.23	177.02	144.27	141.30
Aug. 1,	256.24	184.78	302.41	224.05	176.31	142.13	142.33
Sept. 1,	252.29	184.67	300.53	223.83	176.04	139.81	145.14
Oct. 1,	247.74	184.79	296.70	217.80	175.56	137.84	149.49
Nov. 1,	244.74	184.63	286.79	213.79	175.43	136.20	153.94
Dec. 1,	247.83	183.78	287.38	209.81	177.73	136.08	158.08

ABINGTON AND ROCKLAND.

Water Supply of Abington and Rockland.

Chemical Examination of Water from Big Sandy Pond, Pembroke.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Sus-pended.					
	1900.														
30192	Feb. 14	V. slight.	V. slight.	.10	3.15	1.20	.0002	.0162	.0146	.0016	.56	.0030	.0000	.20	0.5
31187	May 8	V. slight.	V. slight.	.05	3.05	0.75	.0006	.0148	.0136	.0012	.63	.0000	.0001	.21	0.5
32520	Aug. 15	Slight.	V. slight.	.09	3.25	0.85	.0010	.0226	.0188	.0038	.66	.0000	.0001	.21	0.6
33671	Nov. 14	V. slight.	V. slight.	.09	3.35	1.00	.0012	.0152	.0148	.0004	.68	.0010	.0000	.20	0.5
Av...	....	....	....	.08	3.20	0.95	.0007	.0172	.0154	.0018	.63	.0010	.0000	.20	0.4

Odor of the first sample, faintly vegetable, becoming stronger on heating; of the second and last, none; of the third, distinctly vegetable. —— The samples were collected from a faucet in the pumping station.

Acton.

The advice of the State Board of Health to the town of Acton, relative to the quality of the water of a public well in that town, may be found on page 5 of this volume. The results of an analysis of a sample of water from this well are given in the following table: —

Chemical Examination of Water from a Well in Acton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1900.												
33482	Oct. 29	V. slight.	V. slight.	.02	22.00	.0014	.0034	3.57	.3100	.0057	.04	6.9	.0100

Odor, none. —— The sample was collected from a public well, near the Baptist Church in the village of West Acton.

ACTON.

Chemical Examination of Water from Nagog Pond in Acton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30200	Feb. 14	V. slight.	V. slight.	.06	2.20	1.00	.0006	.0202	.0174	.0028	.26	.0030	.0000	.23	0.2
30449	Mar. 13	Slight.	Slight.	.07	2.15	0.90	.0002	.0188	.0162	.0026	.21	.0010	.0001	.20	0.3
30950	Apr. 9	V. slight.	Cons.	.04	1.95	0.85	.0002	.0140	.0130	.0010	.20	.0010	.0000	.18	0.2
31186	May 8	V. slight.	Slight.	.04	2.00	0.75	.0000	.0170	.0146	.0024	.24	.0010	.0000	.23	0.2
31509	June 11	V. slight.	V. slight.	.05	2.00	0.65	.0006	.0166	.0152	.0014	.25	.0010	.0000	.20	0.0
31970	July 9	V. slight.	V. slight.	.01	2.40	1.00	.0006	.0166	.0142	.0024	.24	.0000	.0001	.21	0.2
32461	Aug. 13	V. slight.	V. slight.	.03	2.00	0.60	.0002	.0178	.0142	.0036	.24	.0010	.0000	.17	0.0
32877	Sept. 10	V. slight.	Slight.	.03	1.95	0.70	.0016	.0196	.0168	.0028	.23	.0000	.0000	.24	0.2
33207	Oct. 8	V. slight.	V. slight.	.07	2.00	0.80	.0002	.0154	.0144	.0010	.25	.0010	.0000	.17	0.2
33631	Nov. 12	None.	V. slight.	.10	2.30	0.80	.0012	.0156	.0150	.0006	.24	.0000	.0000	.15	0.2
33999	Dec. 10	None.	V. slight.	.04	2.00	0.75	.0006	.0154	.0140	.0014	.26	.0030	.0000	.13	0.3
Av...	....	....	....	.05	2.09	0.80	.0005	.0170	.0150	.0020	.24	.0011	.0000	.19	0.2

Odor of the second sample, unpleasant; of the others, faintly vegetable or none.

Water Supply of Adams Fire District, Adams.

Chemical Examination of Water from Bassett Brook Reservoir, Adams.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
29970	Jan. 17	None.	None.	.00	3.50	0.90	.0000	.0022	.0022	.0000	.10	.0230	.0000	.10	2.0
30383	Mar. 6	None.	V. slight.	.00	2.15	0.70	.0000	.0034	.0028	.0006	.08	.0210	.0000	.11	1.1
31288	May 17	V. slight.	Slight.	.03	3.45	1.00	.0000	.0060	.0044	.0016	.09	.0050	.0000	.13	2.3
32650	Aug. 24	None.	V. slight.	.02	4.50	0.85	.0006	.0046	.0030	.0016	.07	.0080	.0001	.12	3.6
33820	Nov. 27	None.	None.	.10	2.80	1.05	.0006	.0050	.0050	.0000	.10	.0270	.0000	.27	1.4
Av...	....	....	....	.03	3.28	0.90	.0002	.0042	.0035	.0007	.09	.0168	.0000	.15	2.1

Odor, none. —— The samples were collected from a faucet supplied with water from the reservoir.

ADAMS.

Chemical Examination of Water from Dry Brook Reservoir in Adams and Cheshire.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29971	Jan. 17	None.	None.	.08	6.50	1.60	.0014	.0048	.0048	.0000	.13	.0180	.0000	.20	4.0
30384	Mar. 6	None.	V. slight.	.20	3.90	1.35	.0000	.0066	.0060	.0006	.08	.0070	.0000	.33	2.2
31289	May 17	V. slight.	V. slight.	.10	5.75	1.25	.0000	.0066	.0056	.0010	.09	.0050	.0000	.22	3.9
32651	Aug. 24	V. slight.	V. slight.	.15	9.60	1.50	.0026	.0124	.0114	.0010	.14	.0120	.0001	.34	7.3
33821	Nov. 27	V. slight.	Slight.	.41	5.60	1.85	.0006	.0148	.0144	.0004	.10	.0120	.0000	.71	2.6
Av...	....	....	....	.19	6.27	1.51	.0009	.0090	.0084	.0006	.11	.0108	.0000	.36	4.0

Odor of the first and last samples, none, becoming faintly vegetable on heating; of the second, none; of the third and fourth, faintly vegetable, becoming stronger on heating.—— The samples were collected from a faucet supplied with water from the reservoir.

Adams.

The advice of the State Board of Health to the town of Adams, relative to the quality of the waters of certain springs and wells in that town used for drinking purposes by a considerable number of the inhabitants, may be found on page 5 of this volume. The results of analyses of samples collected from the various sources are given in the following table: —

Chemical Examination of Water from Springs and Wells in Adams.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
32772	Aug. 31	None.	V. slight.	.00	17.30	.0000	.0022	.10	.0530	.0000	.01	13.0	.0060
32940	Sept. 14	None.	None.	.01	15.70	.0000	.0002	.15	.0600	.0000	.00	12.9	.0020
33032	Sept. 21	None.	V. slight.	.00	22.70	.0000	.0004	.29	.1000	.0000	.01	18.6	.0100
32941	Sept. 14	None.	Cons.	.00	23.00	.0004	.0014	.17	.1120	.0000	.01	17.2	.0490

Odor, none.—— The first sample was collected from a spring in the westerly part of the village of Adams, a short distance west of Forest Park Avenue; the second, from the wells beneath the weaving room of the Renfrew Manufacturing Company; the third, from wells located beneath the new bleaching room of the Renfrew Manufacturing Company; the last, from a spring in Linden Street.

AMHERST.

Water Supply of Amherst. — Amherst Water Company.

Chemical Examination of Water from Amethyst Brook Reservoir, Amherst.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30006	Jan. 22	V. slight.	V. slight.	.48	3.40	1.60	.0002	.0166	.0148	.0018	.15	.0020	.0001	.76	0.2
31070	Apr. 23	Slight.	Slight.	.40	2.85	1.30	.0002	.0134	.0130	.0004	.13	.0050	.0000	.59	0.2
32323	July 30	Slight.	Slight.	.35	4.00	1.10	.0056	.0364	.0314	.0050	.11	.0010	.0001	.61	0.5
33541	Nov. 1	V. slight.	V. slight.	.52	4.65	1.60	.0008	.0154	.0148	.0006	.19	.0050	.0001	.72	0.8
Av...	....	....	....	.44	3.72	1.40	.0017	.0204	.0185	.0019	.14	.0032	.0001	.67	0.4

Odor of the second sample, faintly earthy; of the others, none, becoming faintly vegetable or unpleasant on heating.

Water Supply of Andover.

Chemical Examination of Water from Haggett's Pond, Andover.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29875	Jan. 7	V. slight.	None.	.05	2.90	1.05	.0008	.0158	.0154	.0004	.34	.0030	.0000	.18	1.3
30997	Apr. 12	V. slight.	None.	.11	3.05	1.00	.0004	.0134	.0130	.0004	.27	.0010	.0001	.35	1.0
32037	July 16	V. slight.	V. slight.	.11	3.00	1.15	.0002	.0170	.0160	.0010	.28	.0010	.0000	.28	1.3
33307	Oct. 15	V. slight.	V. slight.	.17	3.20	0.90	.0016	.0176	.0166	.0010	.31	.0010	.0000	.24	1.1
Av...	....	....	....	.11	3.04	1.02	.0007	.0159	.0152	.0007	.30	.0015	.0000	.26	1.2

Odor of the last sample, none; of the first and third, none, becoming faintly vegetable on heating; of the second, musty, becoming also distinctly disagreeable on heating. —— The samples were collected from a faucet at the pumping station.

Ashburnham.

Chemical Examination of Water from Upper Naukeag Pond.

[Parts per 100,000]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1900.														
30378	Mar. 5	V. slight.	V. slight.	.22	2.00	0.95	.0006	.0156	.0122	.0034	.08	.0010	.0000	.44	0.0
31730	June 18	V. slight.	Slight.	.09	1.85	0.90	.0014	.0152	.0146	.0006	.09	.0010	.0000	.26	0.0
33160	Oct. 1	V. slight.	Slight.	.03	1.60	0.65	.0020	.0176	.0140	.0036	.10	.0020	.0001	.17	0.0
33880	Dec. 3	None.	V. slight.	.10	1.95	0.85	.0020	.0150	.0134	.0016	.12	.0020	.0000	.28	0.2
Av...	....	....	....	.11	1.85	0.84	.0015	.0158	.0135	.0023	.10	.0015	.0000	.29	0.0

Odor of the last sample, faintly vegetable; of the others, none.

Water Supply of Athol. — Athol Water Company.

Chemical Examination of Water from the Large Reservoir in Phillipston.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1900.														
30404	Mar. 7	Slight.	Slight.	0.43	2.45	1.25	.0100	.0168	.0150	.0018	.09	.0070	.0001	0.62	0.2
31482	June 6	Slight.	Cons.	0.56	3.35	1.75	.0068	.0298	.0242	.0056	.16	.0030	.0000	0.78	0.6
33964	Dec. 6	V. slight.	V. slight.	1.10	4.55	2.55	.0022	.0262	.0230	.0032	.15	.0050	.0000	1.13	1.0
Av...	....	....	....	0.70	3.45	1.85	.0063	.0243	.0207	.0036	.13	.0050	.0000	0.84	0.6

Odor of the first two samples, none, becoming faintly vegetable on heating; of the last, faintly vegetable, becoming stronger on heating.

ATHOL.

Chemical Examination of Water from Buckman Brook Reservoir, Athol.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30403	Mar. 7	V. slight.	V. slight.	.21	2.15	0.90	.0000	.0084	.0080	.0004	.08	.0050	.0001	0.34	0.2
31481	June 6	Slight.	Slight.	.57	3.35	1.65	.0026	.0228	.0206	.0022	.13	.0030	.0000	0.84	0.6
33963	Dec. 6	V. slight.	Slight.	.67	3.10	2.00	.0010	.0194	.0164	.0030	.12	.0040	.0000	1.02	1.0
Av...	....	....	....	.48	2.87	1.52	.0012	.0169	.0150	.0019	.11	.0040	.0000	0.73	0.6

Odor of the first two samples, none; of the last, faintly vegetable, becoming stronger on heating.

Water Supply of Attleborough.

Chemical Examination of Water from the Well of the Attleborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29936	Jan. 12	None.	None.	.00	3.50	.0000	.0024	.36	.0110	.0000	.06	1.8	.0040
30184	Feb. 13	None.	None.	.00	3.60	.0000	.0016	.33	.0100	.0000	.06	1.7	.0050
30620	Mar. 16	None.	None.	.00	3.50	.0000	.0042	.33	.0130	.0000	.04	2.0	.0030
31561	June 12	None.	None.	.01	3.90	.0014	.0046	.28	.0070	.0000	.06	1.6	.0050
32008	July 11	None.	None.	.00	4.00	.0000	.0016	.28	.0080	.0000	.02	1.8	.0020
32524	Aug. 15	None.	None.	.00	3.40	.0002	.0026	.28	.0030	.0000	.08	1.6	.0040
32895	Sept. 12	None.	None.	.00	3.80	.0000	.0036	.30	.0070	.0000	.09	1.4	.0040
33272	Oct. 10	V. slight.	None.	.08	5.00	.0000	.0042	.31	.0070	.0000	.05	1.7	.0100
33657	Nov. 13	None.	None.	.00	4.30	.0002	.0036	.38	.0070	.0000	.08	2.1	.0050
34082	Dec. 13	None.	None.	.00	3.80	.0006	.0038	.39	.0130	.0000	.05	1.7	.0040
Av...	....	....	....	.01	3.88	.0002	.0032	.32	.0086	.0000	.06	1.7	.0046

Odor, none. —— The samples were collected from a faucet at the pumping station.

ATTLEBOROUGH.

The advice of the State Board of Health to S. O. Bigney & Co., relative to the quality of the water of a well beneath their factory, may be found on page 7 of this volume. The results of analyses of samples of water collected from this well are given in the following table : —

Chemical Examination of Water from a Well at the Factory of S. O. Bigney & Co., Attleborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30122	Feb. 6	Decided.	None.	.01	17.80	.0012	.0008	1.54	.0050	.0000	.05	7.7	.1280
30296	Feb. 23	V. slight.	None.	.10	20.20	.0010	.0004	1.76	.0030	.0000	.06	8.9	.1300
31232	May 12	None.	None.	.00	8.50	.0002	.0002	0.59	.0010	.0001	.04	3.8	.0480
31385	May 28	V. slight.	None.	.08	13.20	.0014	.0006	1.17	.0020	.0000	.06	7.0	.0720

Odor, none. —— The samples were collected from a driven well, 50 feet deep, situated beneath the factory of S. O. Bigney & Co., about 20 feet from the Ten Mile River.

Water Supply of Avon.

Chemical Examination of Water from the Well of the Avon Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
31931	July 2	None.	None.	.00	3.10	.0004	.0002	.31	.0170	.0000	.01	1.1	.0030

Odor, none.

Water Supply of Ayer.

The advice of the State Board of Health to the town of Ayer, relative to an additional water supply for that town, may be found on page 7 of this volume. The results of analyses of samples of water collected from a test well are given in one of the following tables : —

AYER.

Chemical Examination of Water from the Well of the Ayer Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
31937	July 2	None.	Slight.	.00	5.10	.0000	.0006	.39	.0300	.0000	.02	2.2	.0050

Odor, none.

Chemical Examination of Water from a Test Well at Ayer.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
31949	July 6	Slight.	Heavy.	.04	5.40	.0222	.0060	.13	.0070	.0000	.15	3.5	.5800
31950	July 6	Slight.	Heavy.	.05	5.30	.0154	.0074	.14	.0060	.0000	.17	3.3	.4200

Odor, none. —— The samples were collected from a test well near the mill pond, not far from the large well from which the supply of the town is drawn.

Water Supply of Barre. — Barre Water Company.

Chemical Examination of Water from the Reservoir of the Barre Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
32836	Sept. 5	V. slight.	Slight.	.05	4.05	1.40	.0022	.0362	.0316	.0046	.17	.0010	.0000	.30	1.1

Odor, none, becoming very faintly fishy on heating.

Water Supply of Belmont.

(See *Metropolitan Water District*, pages 109–128.)

Water Supply of Beverly.

(See also *Salem.*)

The advice of the State Board of Health to the town of Beverly, relative to the effect of the water of the Beverly water supply upon lead service pipes, may be found on page 9 of this volume.

The advice of the State Board of Health to Dr. J. M. Jackson of Beverly Farms, relative to the use of the water of Gravel Pond in Manchester for drinking purposes, may be found on page 9 of this volume. The results of an analysis of a sample of water from this pond are given under "Manchester," in a subsequent portion of this report.

Water Supply of Billerica.

Chemical Examination of Water from the Wells of the Billerica Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30040	Jan. 24	V. slight.	V. slight.	.02	5.80	.0004	.0020	.27	.0090	.0000	.04	2.0	.0320
30356	Feb. 28	V. slight.	V. slight.	.02	6.40	.0002	.0052	.25	.0060	.0000	.06	2.5	.0320
30849	Mar. 28	V. slight.	None.	.02	5.70	.0010	.0020	.28	.0040	.0000	.06	2.9	.0300
31103	Apr. 25	V. slight.	V. slight.	.02	7.00	.0004	.0010	.30	.0110	.0000	.05	2.5	.0210
31337	May 21	None.	None.	.03	5.80	.0010	.0020	.28	.0130	.0000	.09	2.1	.0220
31860	June 26	None.	V. slight.	.07	6.60	.0012	.0016	.27	.0050	.0000	.05	2.7	.0230
32352	Aug. 1	V. slight.	None.	.02	6.50	.0002	.0010	.28	.0050	.0000	.06	2.1	.0220
32776	Aug. 30	V. slight.	V. slight.	.07	6.00	.0012	.0036	.25	.0070	.0000	.02	2.1	.0240
33112	Sept. 26	Slight.	V. slight.	.00	6.20	.0004	.0012	.24	.0040	.0001	.05	2.0	.0250
33528	Oct. 30	V. slight.	V. slight.	.07	6.80	.0010	.0022	.28	.0110	.0000	.03	2.0	.0180
33835	Nov. 27	V. slight.	Slight.	.07	5.90	.0016	.0016	.26	.0160	.0000	.06	2.3	.0320
34263	Dec 28	None.	V. slight.	.04	5.70	.0008	.0022	.28	.0060	.0000	.05	2.2	.0210
Av...	....	....	....	.04	6.20	.0008	.0021	.27	.0081	.0000	.05	2.3	.0252

Odor, none.—— The samples were collected from a faucet at the pumping station.

Blackstone.

The advice of the State Board of Health to the water supply committee of the town of Blackstone, relative to obtaining a supply of water for the town from the public water works of Woonsocket,

BLACKSTONE.

R. I., may be found on page 10 of this volume. The results of analyses of samples of water collected from the sources of supply of Woonsocket are given in the following table: —

Chemical Examination of Water from the Reservoirs of the Woonsocket, R. I., Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30321	Feb. 27	Slight.	Slight.	.59	3.30	1.70	.0034	.0322	.0248	.0074	.19	.0010	.0000	.72	0.3
30322	Feb. 27	V. slight.	V. slight.	.49	2.70	1.20	.0006	.0190	.0182	.0008	.17	.0010	.0000	.60	0.2

Odor, faintly vegetable, becoming stronger on heating.—The first sample was collected from the upper reservoir; the last, from a tap in the pumping station while pumping.

Water Supply of Boston.

(See *Metropolitan Water District*, pages 109–128.)

The advice of the State Board of Health to the Penal Institutions Commissioner of Boston, relative to the quality of the water of a driven well on Deer Island, may be found on page 10 of this volume. The results of analyses of samples of water collected from this well are given in the following table: —

Chemical Examination of Water from a Tubular Well at Deer Island.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30201	Feb. 14	Great.	V. heavy.	.14	36.10*	.0865	.0450	4.50	.0020	.0005	2.05	20.9	.0080*
30247	Feb. 20	Slight.	V. slight.	.04	40.00	.0368	.0010	4.80	.0000	.0001	0.07	20.9	.0480
30355	Mar. 1	Decided.	Heavy.	.00	83.50	.0432	.0032	4.95	.0000	.0003	0.26	12.3	.3400

Odor of No. 30247, none; of No. 30355, none, becoming faintly unpleasant on heating; of No. 30201, faintly unpleasant, becoming stronger on heating.

* Filtered.

WATER SUPPLY OF BRAINTREE.

Chemical Examination of Water from the Filter-gallery of the Braintree Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid		Nitrates.	Nitrites.			
	1900.												
29843	Jan. 2	V. slight.	V. slight.	.12	5.40	.0020	.0144	.89	.0200	.0000	.30	1.3	.0050
30124	Feb. 6	None.	None.	.00	5.90	.0004	.0036	.92	.0980	.0000	.07	2.0	.0050
30387	Mar. 6	Slight.	Slight.	.14	4.50	.0010	.0126	.73	.0330	.0000	.28	1.1	.0110
30915	Apr. 3	V. slight.	V. slight.	.15	3.85	.0012	.0150	.61	.0160	.0002	.34	1.1	.0080
31144	May 1	V. slight.	None.	.08	5.00	.0008	.0090	.76	.0630	.0001	.25	1.4	.0050
31458	June 5	V. slight.	V. slight.	.13	3.65	.0012	.0150	.68	.0190	.0002	.28	1.1	.0180
31942	July 2	V. slight.	V. slight.	.07	4.50	.0002	.0100	.62	.0320	.0000	.18	1.3	.0170
32371	Aug. 6	V. slight.	V. slight.	.12	4.50	.0012	.0148	.68	.0100	.0001	.24	1.0	.0180
32824	Sept. 4	V. slight.	V. slight.	.14	4.00	.0002	.0200	.74	.0040	.0000	.28	0.8	.0080
33163	Oct. 2	None.	V. slight.	.10	5.30	.0034	.0156	.74	.0090	.0000	.24	1.3	.0140
33598	Nov. 6	None.	V. slight.	.05	6.00	.0032	.0060	.85	.0630	.0002	.09	1.7	.0150
33939	Dec. 4	V. slight.	V. slight.	.06	6.10	.0020	.0086	.94	.1500	.0002	.18	2.2	.0100

Averages by Years.

-	1892	-	-	.02	4.69	.0002	.0030	.75	.0192	.0001	-	1.8	.0343
-	1893	-	-	.03	4.72	.0002	.0049	.83	.0363	.0001	.10	1.8	.0037
-	1894	-	-	.04	5.19	.0004	.0048	.86	.0338	.0001	.10	1.7	.0135
-	1895	-	-	.12	5.32	.0004	.0060	.89	.0369	.0002	.13	2.0	.0417
-	1896	-	-	.08	5.55	.0006	.0051	.86	.0329	.0000	.12	1.7	.0095
-	1897	-	-	.04	5.20	.0010	.0058	.90	.0287	.0001	.10	2.0	.0059
-	1898	-	-	.07	5.22	.0013	.0049	.88	.0482	.0000	.12	2.0	.0059
-	1899	-	-	.04	5.20	.0020	.0044	.81	.0363	.0000	.09	1.9	.0051
-	1900	-	-	.10	4.89	.0014	.0120	.76	.0431	.0001	.23	1.4	.0112

NOTE to analyses of 1900: Odor of No. 30915, very faintly unpleasant, becoming stronger on heating; of the others, none.——The samples were collected from a faucet at the pumping station. The samples represent water from the filter-gallery mingled with unfiltered water from Little Pond.

BRAINTREE.

Chemical Examination of Water from Little Pond, Braintree.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30123	Feb. 6	V. slight.	V. slight.	.15	4.20	1.70	.0022	.0206	.0200	.0006	.75	.0110	.0001	.42	1.0
30914	Apr. 3	V. slight.	Slight.	.17	4.00	1.25	.0012	.0206	.0174	.0032	.62	.0180	.0003	.42	1.4
31457	June 5	Slight.	Slight.	.24	3.70	1.05	.0022	.0236	.0218	.0018	.64	.0030	.0001	.43	0.8
32370	Aug. 6	V. slight.	Slight.	.18	4.20	1.30	.0004	.0270	.0234	.0036	.68	.0000	.0000	.39	0.8
33162	Oct. 2	V. slight.	Slight.	.21	4.45	1.25	.0042	.0234	.0222	.0012	.73	.0030	.0000	.38	0.6
33938	Dec. 4	V. slight.	Slight.	.14	3.80	1.45	.0052	.0208	.0114	.0094	.68	.0060	.0001	.43	1.1
Av...	....	....	....	.18	4.06	1.33	.0026	.0227	.0194	.0033	.68	.0068	.0001	.41	0.9

Odor, faintly vegetable or unpleasant, becoming stronger on heating.

Water Supply of Bridgewater and East Bridgewater. — The Bridgewaters Water Company.

Chemical Examination of Water from the Wells of the Bridgewaters Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid		Nitrates.	Nitrites.			
	1900.												
30305	Feb. 26	Decided.	Cons.	.13	8.70	.0010	.0006	.34	.0010	.0000	.02	3.0	.1460
31068	Apr. 23	V. slight.	Cons.	.19	8.20	.0010	.0012	.42	.0030	.0000	.05	2.9	.1200
31844	June 25	Slight.	Cons.	.19	8.50	.0008	.0008	.40	.0020	.0001	.03	2.7	.1020
32586	Aug. 22	Slight.	V. slight.	.10	7.00	.0006	.0056	.51	.0190	.0000	.08	2.1	.0250
33409	Oct. 24	Slight.	Heavy.	.09	8.40	.0010	.0006	.40	.0010	.0000	.02	2.7	.2430
34242	Dec. 27	Decided	Cons.	.17	6.80	.0018	.0024	.44	.0050	.0000	.05	2.6	.1900
Av...	....	....	....	.14	7.93	.0010	.0019	.42	.0052	.0000	.04	2.7	.1377

Odor, none. —— The samples were collected from a faucet at the pumping station.

WATER SUPPLY OF BROCKTON.

Chemical Examination of Water from Salisbury Brook Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29850	Jan. 3	Slight.	Slight.	.75	5.00	2.10	.0016	.0270	.0244	.0026	.39	.0040	.0000	.80	0.8
30141	Feb. 6	V. slight.	V. slight.	.65	4.75	2.00	.0016	.0248	.0226	.0022	.40	.0020	.0000	.78	0.8
30382	Mar. 6	Slight.	V. slight.	.51	3.35	1.60	.0000	.0178	.0160	.0018	.33	.0010	.0000	.70	0.3
30925	Apr. 4	V. slight.	V. slight.	.40	3.15	1.40	.0002	.0140	.0132	.0008	.34	.0010	.0000	.54	0.3
31189	May 9	V. slight.	Cons.	.51	3.15	1.50	.0012	.0234	.0166	.0068	.29	.0010	.0001	.64	0.3
31472	June 5	Slight.	Cons.	.68	3.65	1.70	.0040	.0240	.0204	.0036	.29	.0000	.0000	.78	0.2
31932	July 2	Slight.	Cons.	.75	3.30	1.30	.0000	.0258	.0218	.0040	.30	.0000	.0000	.79	0.5
32382	Aug. 6	Slight.	Slight.	.70	3.60	1.60	.0004	.0280	.0232	.0048	.30	.0000	.0000	.76	0.3
32808	Sept. 4	Slight.	Cons.	.53	3.45	1.35	.0026	.0236	.0216	.0020	.33	.0020	.0000	.62	0.3
33169	Oct. 2	Slight.	Cons.	.44	3.15	1.20	.0006	.0246	.0200	.0046	.32	.0010	.0000	.55	0.5
33607	Nov. 7	Slight.	Cons.	.36	3.85	1.30	.0016	.0284	.0124	.0160	.37	.0010	.0000	.52	0.5
33941	Dec. 4	Slight.	Cons.	.58	4.25	1.90	.0016	.0258	.0220	.0038	.38	.0010	.0001	.84	1.0

Averages by Years.

-	1888	-	-	.76	3.76	1.61	.0031	.0369	-	-	.31	.0066	.0001	-	-
-	1889	-	-	.78	2.79	1.01	.0028	.0306	.0218	.0088	.30	.0048	.0002	-	-
-	1890	-	-	.75	4.07	1.98	.0016	.0274	.0219	.0055	.32	.0063	.0001	-	0.9
-	1891	-	-	.62	3.15	1.45	.0010	.0213	.0169	.0044	.28	.0061	.0001	-	0.6
-	1892	-	-	.55	3.41	1.37	.0004	.0213	.0168	.0045	.36	.0030	.0000	-	0.7
-	1893	-	-	.67	3.59	1.70	.0007	.0237	.0196	.0041	.40	.0019	.0001	.65	0.7
-	1894	-	-	.81	3.71	1.63	.0012	.0228	.0188	.0040	.44	.0021	.0000	.66	0.7
-	1895	-	-	.80	3.75	1.86	.0009	.0263	.0224	.0039	.43	.0018	.0000	.74	0.9
-	1896	-	-	.64	3.59	1.55	.0007	.0224	.0186	.0038	.38	.0022	.0000	.66	0.6
-	1897	-	-	.85	3.80	1.72	.0011	.0236	.0195	.0041	.44	.0020	.0000	.75	0.8
-	1898	-	-	.73	3.72	1.92	.0009	.0237	.0207	.0030	.37	.0012	.0000	.79	0.8
-	1899	-	-	.48	3.24	1.40	.0007	.0226	.0187	.0039	.31	.0015	.0000	.58	0.5
-	1900	-	-	.57	3.72	1.58	.0013	.0239	.0195	.0044	.34	.0012	.0000	.69	0.5

NOTE to analyses of 1900: Odor, faintly vegetable or none. A vegetable odor was developed in all of the samples on heating.——The samples were collected from the reservoir, near the gate-house, 1 foot beneath the surface.

Microscopical Examination of Water from Salisbury Brook Storage Reservoir.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	4	9	7	5	9	6	5	7	6	3	8	6
Number of sample,	29850	30141	30382	30925	31189	31472	31932	32382	32808	33169	33607	33941
PLANTS.												
Diatomaceæ,	**95**	**169**	**79**	**169**	**235**	**14**	**5,461**	**68**	**76**	**454**	**2,148**	**1,150**
Asterionella,	89	163	72	128	196	4	576	55	13	264	188	204
Synedra,	5	0	2	4	4	1	4	1	2	9	150	112
Tabellaria,	0	6	5	34	22	8	4,880	12	51	161	1,780	832
Algæ,	**0**	**0**	**0**	**0**	**0**	**0**	**46**	**1**	**7**	**2**	**10**	**1**

BROCKTON.

Microscopical Examination of Water from Salisbury Brook Storage Reservoir — Concluded.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.												
Infusoria,	11	11	24	177	8	5	66	20	2	0	90	7
Dinobryon,	0	0	19	175	3	0	66	0	0	0	0	0
Peridinium,	3	9	5	2	4	1	0	11	0	0	78	7
Vermes,	2	0	0	0	2	0	0	0	0	2	6	0
Crustacea,	0	0	0	0	0	0	pr.	0	0	0	4	0
Cyclops,	0	0	0	0	0	0	pr.	0	0	0	0	0
Entomostracan ova,	0	0	0	0	0	0	0	0	0	0	4	0
Miscellaneous, Zoöglœa,	3	3	3	7	3	5	3	5	3	5	10	3
TOTAL,	111	183	106	353	248	24	5,576	94	88	463	2,268	1,161

WATER SUPPLY OF BROOKLINE.

Chemical Examination of Water from a Faucet at the Low-service Pumping Station of the Brookline Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29952	Jan. 15	None.	None.	.00	9.30	.0026	.0020	.61	.0400	.0002	.08	4.6	.0030
31020	Apr. 16	None.	None.	.00	9.00	.0020	.0040	.56	.0420	.0000	.08	4.2	.0040
31787	June 19	None.	None.	.00	8.90	.0020	.0034	.56	.0320	.0002	.13	4.7	.0050
32564	Aug. 20	V. slight.	None.	.02	9.50	.0034	.0034	.55	.0330	.0004	.09	4.4	.0100
33589	Nov. 5	None.	None.	.04	9.10	.0040	.0036	.60	.0400	.0004	.07	4.3	.0060
34214	Dec. 24	None.	None.	.00	9.70	.0034	.0038	.58	.0540	.0003	.10	4.9	.0130

Averages by Years.

-	1888	-	-	.04	6.76	.0002	.0049	.52	.0326	.0000	-	-	-
-	1894	-	-	.02	9.01	.0010	.0017	.65	.0308	.0001	.06	4.5	.0035
-	1895	-	-	.02	9.15	.0005	.0026	.60	.0361	.0000	.07	4.4	.0022
-	1896	-	-	.03	8.48	.0007	.0031	.57	.0302	.0000	.10	4.6	.0018
-	1897	-	-	.03	9.02	.0015	.0041	.56	.0358	.0000	.10	4.6	.0012
-	1898	-	-	.07	8.85	.0012	.0041	.56	.0321	.0001	.13	4.3	.0032
-	1899	-	-	.03	8.65	.0020	.0032	.56	.0315	.0002	.09	4.2	.0022
-	1900	-	-	.01	9.25	.0029	.0034	.58	.0403	.0002	.09	4.5	.0068

NOTE to analyses of 1900: Odor, none.

CAMBRIDGE.

Water Supply of Cambridge.

Chemical Examination of Water from Fresh Pond, Cambridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29844	Jan. 2	V. slight.	Cons.	.12	6.90	1.95	.0072	.0246	.0196	.0050	.63	.0180	.0010	.33	2.7
30119	Feb. 5	Slight.	Cons.	.13	6.70	2.20	.0052	.0228	.0202	.0026	.56	.0100	.0002	.32	3.1
30391	Mar. 5	Decided.	Cons.	.20	6.40	1.95	.0012	.0214	.0176	.0038	.53	.0260	.0006	.34	2.7
30903	Apr. 3	Slight.	Cons.	.14	6.10	1.50	.0006	.0222	.0158	.0064	.54	.0240	.0006	.36	3.0
31139	May 1	Slight.	Cons.	.10	6.10	1.55	.0026	.0224	.0162	.0062	.57	.0220	.0002	.40	2.7
31430	June 4	Slight.	Cons.	.21	6.15	1.55	.0040	.0208	.0178	.0030	.55	.0180	.0002	.38	3.0
31945	July 3	V. slight.	Slight.	.12	5.80	1.50	.0052	.0280	.0184	.0096	.44	.0110	.0006	.41	3.1
32390	Aug. 6	Slight.	Cons.	.16	6.35	1.80	.0016	.0578	.0260	.0318	.55	.0010	.0002	.43	2.9
32821	Sept. 1	V. slight.	Slight.	.11	6.60	1.55	.0192	.0270	.0214	.0056	.54	.0060	.0007	.34	2.6
33161	Oct. 2	V. slight.	Cons.	.12	5.75	1.25	.0016	.0286	.0230	.0056	.53	.0050	.0003	.32	2.9
33587	Nov. 6	V. slight.	Cons.	.18	6.60	1.50	.0252	.0290	.0194	.0096	.54	.0050	.0005	.31	2.9
33907	Dec. 4	Slight.	Slight.	.25	6.35	1.70	.0320	.0260	.0192	.0068	.56	.0080	.0006	.35	3.0

Averages by Years.

-	1888	-	-	.17	11.14	1.79	.0132	.0206	-	-	1.10	.0261	.0007	-	-
-	1889	-	-	.11	9.86	1.83	.0145	.0220	.0170	.0050	0.90	.0334	.0008	-	-
-	1890	-	-	.11	8.90	1.34	.0098	.0221	.0168	.0053	0.83	.0303	.0004	-	4.1
-	1891	-	-	.15	7.94	1.80	.0095	.0235	.0162	.0073	0.75	.0333	.0004	-	3.8
-	1892	-	-	.16	7.23	1.57	.0086	.0210	.0161	.0049	0.67	.0249	.0003	-	3.4
-	1893	-	-	.27	6.66	1.82	.0106	.0202	.0165	.0037	0.58	.0285	.0006	.40	3.2
-	1894	-	-	.30	6.98	1.81	.0063	.0199	.0162	.0037	0.66	.0183	.0007	.41	3.1
-	1895	-	-	.35	7.43	2.15	.0054	.0245	.0189	.0055	0.69	.0221	.0004	.47	3.3
-	1896	-	-	.29	7.68	2.10	.0020	.0220	.0175	.0045	0.72	.0372	.0006	.42	3.4
-	1897	-	-	.36	7.87	2.20	.0046	.0220	.0176	.0044	0.66	.0265	.0006	.42	3.5
-	1898	-	-	.35	7.07	2.27	.0069	.0232	.0187	.0045	0.60	.0320	.0006	.46	3.2
-	1899	-	-	.20	6.90	2.05	.0048	.0267	.0206	.0061	0.56	.0332	.0005	.39	3.1
-	1900	-	-	.15	6.32	1.67	.0088	.0275	.0195	.0080	0.54	.0128	.0005	.36	2.9

Note to analyses of 1900: Odor, generally faintly vegetable, becoming stronger, and sometimes also unpleasant or grassy, on heating. —— The samples were collected from the pump well at the pumping station.

CAMBRIDGE.

Microscopical Examination of Water from Fresh Pond, Cambridge.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	3	6	8	3	2	4	5	8	6	3	7	5
Number of sample,	29844	30119	30391	30903	31139	31430	31945	32390	32821	33161	33587	33907
PLANTS.												
Diatomaceæ,	1,604	926	1,083	7,232	3,056	1,278	64	10	12	752	776	908
Asterionella,	656	598	574	1,860	2,208	952	10	0	0	94	52	482
Cyclotella,	180	170	280	5,000	224	14	0	4	0	6	22	114
Fragilaria,	332	32	14	56	72	116	50	0	0	556	126	104
Melosira,	120	30	107	146	64	10	0	6	12	60	488	54
Synedra,	200	58	77	152	368	2	4	0	0	10	8	2
Tabellaria,	112	38	31	16	120	184	0	0	0	24	80	136
Cyanophyceæ,	0	0	0	0	4	3	200	1,326	142	164	102	10
Anabæna,	0	0	0	0	0	2	190	1,320	109	16	16	0
Cœlosphærium,	0	0	0	0	0	1	10	6	33	148	84	10
Algæ,	8	12	4	0	48	93	160	68	34	108	66	66
Protococcus,	0	8	0	0	32	24	76	66	29	0	0	0
Staurastrum,	0	2	0	0	4	50	80	2	3	86	64	66
ANIMALS.												
Infusoria,	0	10	2	4	0	17	6	10	0	0	2	2
Ceratium,	0	0	0	0	0	1	6	10	0	0	0	0
Uroglena,	0	0	0	0	0	8	0	0	0	0	0	0
Vermes,	0	0	0	2	0	5	0	0	1	0	0	0
Crustacea, Cyclops,	pr.	0	pr.	0	pr.	pr.	0	0	0	pr.	pr.	pr.
Miscellaneous, Zoöglœa,	6	5	8	5	14	8	6	6	5	3	5	3
TOTAL,	1,618	953	1,097	7,243	3,122	1,404	436	1,420	194	1,027	951	989

CAMBRIDGE.

Chemical Examination of Water from Stony Brook Storage Reservoir, Waltham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
29839	Jan. 2	V. slight.	Slight.	.23	6.20	2.35	.0012	.0270	.0224	.0046	.53	.0140	.0001	.48	2.3
30105	Feb. 5	Decided.	Slight.	.36	5.95	2.00	.0052	.0302	.0242	.0060	.43	.0200	.0001	.62	2.3
30365	Mar. 5	Slight.	V. slight.	.40	4.20	1.45	.0012	.0232	.0214	.0018	.31	.0110	.0002	.59	1.1
30901	Apr. 3	Slight.	Slight.	.34	4.40	1.45	.0006	.0212	.0190	.0022	.35	.0070	.0002	.51	1.7
31135	May 1	Slight.	Cons.	.45	4.25	1.70	.0006	.0260	.0228	.0032	.39	.0050	.0001	.68	1.8
31422	June 4	Slight.	Slight.	.68	5.05	1.80	.0004	.0286	.0246	.0040	.40	.0020	.0002	.80	1.7
31899	July 2	V. slight.	V. slight.	.47	5.05	1.60	.0040	.0306	.0252	.0054	.38	.0060	.0003	.68	2.1
32367	Aug. 6	V. slight.	Slight.	.20	4.75	1.25	.0006	.0228	.0198	.0030	.41	.0010	.0001	.43	2.1
32779	Sept. 4	V. slight.	V. slight.	.18	4.65	1.35	.0002	.0208	.0198	.0010	.39	.0010	.0000	.34	1.8
33149	Oct. 2	Slight.	Slight.	.21	5.15	1.25	.0018	.0248	.0212	.0036	.37	.0020	.0001	.38	2.1
33581	Nov. 6	V. slight.	Slight.	.30	5.20	1.60	.0064	.0258	.0238	.0020	.48	.0030	.0002	.45	2.1
33906	Dec. 4	Slight.	Cons.	.37	6.05	1.50	.0036	.0248	.0230	.0018	.48	.0080	.0001	.61	2.5

Averages by Years.

-	1888	-	-	.78	5.15	1.93	.0031	.0285	-	-	.34	.0169	.0002	-	-
-	1889	-	-	.87	4.59	1.47	.0032	.0280	.0249	.0031	.38	.0162	.0003	-	-
-	1890	-	-	.61	5.86	2.02	.0016	.0222	.0182	.0040	.37	.0208	.0002	-	2.3
-	1891	-	-	.56	4.99	1.86	.0016	.0213	.0183	.0030	.34	.0163	.0001	-	1.9
-	1892	-	-	.72	5.43	1.79	.0015	.0241	.0202	.0039	.37	.0208	.0001	-	2.2
-	1893	-	-	.66	5.32	1.97	.0020	.0255	.0196	.0039	.44	.0208	.0001	.60	2.1
-	1894	-	-	.73	5.61	2.03	.0018	.0211	.0189	.0022	.46	.0174	.0001	.64	2.1
-	1895	-	-	.84	5.90	2.41	.0015	.0280	.0235	.0045	.49	.0253	.0001	.79	2.2
-	1896	-	-	.61	5.98	2.08	.0026	.0250	.0219	.0031	.49	.0219	.0001	.65	2.2
-	1897	-	-	.69	6.40	2.32	.0026	.0273	.0236	.0037	.47	.0204	.0002	.66	2.4
-	1898	-	-	.69	5.67	2.40	.0014	.0246	.0220	.0026	.46	.0182	.0002	.66	2.1
-	1899	-	-	.28	5.10	1.80	.0014	.0221	.0199	.0022	.39	.0151	.0002	.46	2.0
-	1900	-	-	.35	5.07	1.61	.0021	.0255	.0223	.0032	.41	.0067	.0001	.55	2.0

Note to analyses of 1900: Odor, generally faintly vegetable or unpleasant, becoming stronger on heating. A fishy odor was developed in No. 29839, on heating. —— The samples were collected from the reservoir, near the surface, at the dam.

CAMBRIDGE.

Microscopical Examination of Water from Stony Brook Storage Reservoir, Waltham.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	3	5	6	3	1	4	2	7	4	2	7	5
Number of sample,	29839	30105	30365	30901	31135	31422	31899	32367	32779	33149	33581	33906
PLANTS.												
Diatomaceæ,	38	24	106	1,702	4,625	827	14	100	75	332	772	1,166
Asterionella,	7	2	5	336	4,600	38	0	0	33	248	606	758
Cyclotella,	22	4	9	0	0	0	0	52	33	5	20	100
Synedra,	8	5	91	1,340	0	762	3	11	0	0	8	4
Tabellaria,	0	10	0	22	25	27	0	31	9	74	138	304
Cyanophyceæ,	0	0	0	0	0	1	411	0	0	32	4	0
Anabæna,	0	0	0	0	0	1	411	0	0	31	0	0
Algæ,	0	0	5	0	8	6	69	46	26	6	12	0
Protococcus,	0	0	0	0	8	0	57	36	21	0	0	0
ANIMALS.												
Rhizopoda, Arcella,	0	0	0	0	0	0	0	1	0	0	0	0
Infusoria,	103	45	27	30	23	235	3	1	3	18	0	2
Chlamydomonas,	13	44	14	4	6	208	0	0	0	0	0	0
Dinobryon,	65	0	8	10	0	26	0	0	0	0	0	0
Peridinium,	4	1	3	8	17	1	0	1	2	4	0	0
Uroglena,	16	0	2	0	0	0	0	0	0	8	0	0
Vermes,	6	1	1	1	3	0	0	0	0	0	0	0
Crustacea, Cyclops,	0	0	0	0	0	0	pr.	pr.	0	pr.	0	0
Miscellaneous, Zoöglœa,	5	8	8	14	5	10	10	5	6	5	3	5
TOTAL,	152	78	147	1,747	4,664	1,079	507	153	110	393	791	1,173

CAMBRIDGE.

Chemical Examination of Water from the Upper Basin on Hobbs Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
29840	Jan. 2	Decided.	Slight.	.30	6.85	2.85	.0024	.0380	.0316	.0064	.45	.0080	.0001	.71	2.9
30113	Feb. 5	Decided.	Slight.	.26	4.70	1.95	.0054	.0314	.0234	.0080	.26	.0060	.0003	.57	2.0
30366	Mar. 5	Decided.	Slight.	.60	4.15	1.80	.0030	.0334	.0276	.0058	.25	.0110	.0002	.76	0.8
30898	Apr. 2	Slight.	Cons.	.45	4.10	1.75	.0022	.0272	.0214	.0058	.26	.0050	.0001	.63	1.3
31154	May 3	Decided.	Cons.	.50	4.50	1.75	.0012	.0312	.0238	.0074	.33	.0020	.0001	.72	1.6
31439	June 4	Slight.	Cons.	.70	5.30	2.10	.0012	.0368	.0296	.0072	.34	.0010	.0000	.88	2.0
31938	July 2	Slight.	Cons.	.50	8.25	2.75	.0018	.0396	.0294	.0102	.33	.0010	.0000	.81	2.0
32376	Aug. 6	Decided.	Cons.	.37	5.50	1.90	.0032	.0536	.0428	.0108	.38	.0010	.0002	.92	2.0
32791	Sept. 4	Decided.	Cons.	.29	5.40	2.15	.0014	.0386	.0278	.0108	.39	.0010	.0000	.71	1.8
33158	Oct. 2	Decided.	Cons.	.27	5.40	2.00	.0008	.0350	.0290	.0060	.36	.0010	.0000	.63	2.0
33591	Nov. 6	Decided.	Cons.	.24	5.35	1.90	.0026	.0322	.0280	.0042	.39	.0020	.0000	.59	2.0
33935	Dec. 4	Slight.	Cons.	.32	5.90	2.40	.0026	.0356	.0268	.0088	.34	.0030	.0001	.69	2.5
Av...	1900	....	....	.40	5.45	2.11	.0023	.0360	.0284	.0076	.34	.0035	.0001	.72	1.9
Av...	1899	....	....	.34	5.04	2.06	.0024	.0339	.0270	.0069	.33	.0050	.0000	.64	1.7

Odor, generally vegetable or unpleasant, becoming stronger, and frequently fishy, on heating.— The samples were collected from the basin, near its outlet into the lower basin.

Microscopical Examination of Water from the Upper Basin on Hobbs Brook.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	3	6	6	3	3	5	3	7	5	2	8	6
Number of sample,	29840	30113	30366	30898	31154	31439	31938	32376	32791	33158	33591	33935
PLANTS.												
Diatomaceæ,	296	562	123	1,546	7,400	1,052	1,116	2,580	1,639	150	826	295
Melosira,	0	0	0	0	0	20	584	2,056	1,514	60	802	152
Synedra,	296	562	115	1,480	7,200	1,012	492	492	124	90	18	127
Tabellaria,	0	0	0	62	156	16	40	4	0	0	0	0
Cyanophyceæ, Anabæna,	0	0	0	0	64	0	0	0	0	0	0	0
Algæ,	0	16	9	0	0	36	90	100	29	76	20	8
Arthrodesmus,	0	0	0	0	0	4	66	0	0	0	0	0
Staurastrum,	0	0	0	0	0	32	8	84	14	74	6	0

CAMBRIDGE.

Microscopical Examination of Water from the Upper Basin on Hobbs Brook — Concluded.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	1	0	0	0	0	0	0	0	0
Infusoria,	126	89	11	150	76	4	14	172	40	150	594	1,790
Chlamydomonas,	12	0	0	2	12	4	6	44	19	0	2	0
Dinobryon,	96	78	3	148	0	0	0	0	8	144	584	1,780
Euglena,	0	0	0	0	32	0	0	4	0	0	0	0
Peridinium,	0	3	8	0	8	0	2	112	11	2	2	7
Uroglena,	14	1	0	0	24	0	0	0	0	0	0	0
Vermes,	0	1	0	0	0	0	0	4	0	4	4	1
Miscellaneous, Zoöglœa,	6	10	9	10	6	10	20	14	15	3	5	7
TOTAL,	428	678	152	1,707	7,546	1,102	1,240	2,870	1,723	383	1,449	2,101

Chemical Examination of Water from the Lower Basin on Hobbs Brook, at Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29841	Jan. 2	Slight.	Slight.	.11	5.20	1.70	.0030	.0338	.0272	.0066	.42	.0030	.0000	.47	2.0
30114	Feb. 5	V. slight.	V. slight.	.08	4.65	1.75	.0002	.0218	.0182	.0036	.34	.0010	.0001	.29	2.0
30367	Mar. 5	V. slight.	V. slight.	.12	4.55	1.50	.0010	.0246	.0212	.0034	.35	.0020	.0001	.40	1.7
30899	Apr. 2	Slight.	Cons.	.15	4.50	1.45	.0022	.0280	.0196	.0084	.31	.0020	.0001	.45	1.8
31155	May 3	Slight.	Cons.	.12	4.70	1.70	.0008	.0298	.0230	.0068	.34	.0010	.0001	.48	1.7
31440	June 4	Slight.	Slight.	.12	4.40	1.30	.0004	.0266	.0214	.0052	.36	.0000	.0000	.45	2.1
31939	July 2	V. slight.	Slight.	.10	4.65	1.40	.0000	.0300	.0218	.0082	.35	.0010	.0000	.44	2.0
32377	Aug. 6	Slight.	Slight.	.11	5.25	1.55	.0010	.0278	.0248	.0030	.35	.0010	.0000	.42	2.0
32792	Sept. 4	Decided.	Cons.	.09	4.80	1.40	.0012	.0258	.0214	.0044	.38	.0020	.0000	.37	1.7
33159	Oct. 2	Slight.	Slight.	.10	4.75	1.50	.0010	.0292	.0246	.0046	.38	.0020	.0000	.39	1.8
33592	Nov. 6	Slight.	Slight.	.11	4.55	1.40	.0010	.0270	.0248	.0022	.38	.0010	.0000	.43	1.7
33936	Dec. 4	Slight.	Slight.	.10	4.80	1.80	.0026	.0282	.0240	.0042	.33	.0010	.0001	.38	2.2
Av...	1900	....	....	.11	4.73	1.54	.0012	.0277	.0227	.0050	.36	.0014	.0000	.41	1.9
Av...	1899	....	....	.12	4.66	1.56	.0020	.0251	.0221	.0030	.34	.0074	.0001	.39	1.7

Odor, generally vegetable or unpleasant, becoming stronger on heating. A fishy odor was developed in No. 32377 on heating. —— The samples were collected from the reservoir, near the dam.

CAMBRIDGE.

Microscopical Examination of Water from the Lower Basin on Hobbs Brook, at Surface.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	3	6	6	3	3	5	3	7	5	2	8	6
Number of sample,	29841	30114	30367	30899	31155	31440	31939	32377	32792	33159	33592	33936
PLANTS.												
Diatomaceæ,	162	207	208	2,789	6,148	1,190	483	342	287	235	131	54
Asterionella,	0	4	0	53	68	14	0	0	0	5	0	4
Melosira,	0	0	0	0	0	6	0	0	82	172	95	6
Synedra,	162	196	206	2,720	6,040	1,128	476	342	185	55	17	43
Cyanophyceæ,	0	0	0	0	0	3	0	0	1	0	0	0
Algæ,	2	9	2	3	4	31	8	52	80	17	43	26
ANIMALS.												
Infusoria,	298	203	91	37	392	430	0	42	18	14	8	5
Chlamydomonas,	0	182	48	2	372	424	0	28	2	4	0	0
Dinobryon,	220	5	35	9	0	0	0	10	6	0	6	0
Peridinium,	0	15	6	19	16	0	0	0	6	10	0	1
Uroglena,	78	0	2	3	0	2	0	0	0	0	0	1
Vermes,	0	2	0	3	8	1	0	0	0	0	0	1
Crustacea, Cyclops,	0	0	0	0	0	0	0	0	0	pr.	0	0
Miscellaneous, Zoöglœa,	6	5	7	7	10	7	5	8	8	3	7	3
TOTAL,	468	426	308	2,839	6,562	1,662	496	444	394	269	189	89

CAMBRIDGE.

Chemical Examination of Water from the Lower Basin on Hobbs Brook at Bottom.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
29842	Jan. 2	V. slight.	Slight.	.06	5.00	1.65	.0002	.0232	.0192	.0040	.38	.0020	.0000	.34	2.0
30115	Feb. 5	V. slight.	V. slight.	.06	4.75	1.75	.0004	.0202	.0176	.0026	.35	.0010	.0000	.31	2.1
30368	Mar. 5	V. slight.	V. slight.	.12	4.80	1.65	.0002	.0246	.0182	.0064	.35	.0010	.0001	.39	1.8
30900	Apr. 2	Slight.	Cons.	.15	4.50	1.45	.0002	.0264	.0176	.0088	.29	.0050	.0002	.42	1.8
31156	May 3	V. slight.	Cons.	.12	4.50	1.50	.0002	.0236	.0174	.0062	.34	.0010	.0001	.43	1.7
31441	June 4	Slight.	Slight.	.11	4.25	1.45	.0004	.0260	.0200	.0060	.35	.0010	.0000	.43	2.0
31940	July 2	V. slight.	Slight.	.09	4.90	1.45	.0004	.0238	.0188	.0050	.36	.0000	.0000	.42	2.0
32378	Aug. 6	Slight.	Slight.	.11	5.20	1.55	.0004	.0258	.0202	.0056	.36	.0010	.0000	.42	2.1
32793	Sept. 4	Decided.	Cons.	.10	4.75	1.50	.0002	.0254	.0200	.0054	.37	.0000	.0000	.35	1.8
33160	Oct. 2	V. slight.	Slight.	.09	4.70	1.50	.0004	.0238	.0198	.0040	.35	.0020	.0000	.33	2.1
33593	Nov. 6	Slight.	Cons.	.10	5.00	1.40	.0012	.0246	.0202	.0044	.38	.0020	.0000	.36	1.7
33937	Dec. 4	Slight.	Slight.	.07	4.75	1.85	.0018	.0226	.0184	.0042	.32	.0020	.0001	.40	2.1
Av...	1900	....	....	.10	4.76	1.56	.0005	.0242	.0190	.0052	.35	.0015	.0000	.38	1.9
Av...	1899	....	....	.15	4.86	1.68	.0013	.0225	.0191	.0034	.35	.0087	.0001	.39	1.9

Odor, generally vegetable or unpleasant, sometimes none. The odor of most of the samples became unpleasant, and in September also fishy, on heating. —— The samples were collected from the reservoir, near the dam.

Water Supply of Canton.

Chemical Examination of Water from the Springdale Well of the Canton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1900.												
29935	Jan. 11	None.	None.	.00	3.70	.0000	.0006	.33	.0040	.0000	.02	0.8	.0040
30630	Mar. 19	None.	None.	.00	3.40	.0000	.0008	.33	.0020	.0000	.02	0.5	.0020
31201	May 9	None.	None.	.00	4.00	.0000	.0006	.33	.0000	.0000	.04	1.3	.0020
31947	July 5	V. slight.	Slight.	.00	3.40	.0002	.0028	.29	.0040	.0000	.03	0.5	.0160
33079	Sept. 24	None.	None.	.00	2.80	.0010	.0004	.30	.0030	.0000	.00	0.5	.0040
33557	Nov. 5	None.	None.	.00	3.20	.0000	.0016	.32	.0020	.0000	.01	0.6	.0010
Av...	....	....	....	.00	3.42	.0002	.0011	.32	.0025	.0000	.02	0.7	0048

Odor, none.

CANTON.

Chemical Examination of Water from the Well near Henry's Spring, Canton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29934	Jan. 11	None.	None.	.00	4.20	.0000	.0010	.40	.0140	.0000	.02	0.8	.0060
30629	Mar. 19	None.	V. slight.	.00	4.20	.0000	.0020	.38	.0140	.0000	.07	1.0	.0040
31200	May 9	None.	None.	.08	4.10	.0000	.0024	.36	.0140	.0000	.16	1.3	.0020
31946	July 5	None.	V. slight.	.02	3.50	.0004	.0012	.38	.0120	.0000	.06	1.0	.0050
33078	Sept. 24	None.	None.	.00	4.10	.0000	.0006	.36	.0210	.0001	.01	0.8	.0050
33556	Nov. 5	None.	V. slight.	.00	4.10	.0002	.0022	.38	.0190	.0000	.01	1.0	.0120
Av...	....	....	....	.02	4.03	.0001	.0016	.38	.0157	.0000	.05	1.0	.0057

Odor, none.

Water Supply of Chelsea.

(See *Metropolitan Water District*, pages 109–128.)

Water Supply of Cheshire. — Cheshire Water Company.

Chemical Examination of Water from the Old Reservoir of the Cheshire Water Company on Thunder Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30007	Jan. 22	None.	V. slight.	.01	2.50	0.70	.0002	.0042	.0038	.0004	.07	.0100	.0000	.10	1.4
31965	July 9	None.	V. slight.	.01	7.00	0.90	.0020	.0036	.0026	.0010	.08	.0120	.0000	.09	5.6
32362	July 31	None.	V. slight.	.00	7.80	0.55	.0028	.0038	.0028	.0010	.08	.0120	.0000	.05	6.3

Odor, none. A faintly vegetable odor was developed in the last two samples on heating.

CHESHIRE.

Chemical Examination of Water from the New Reservoir of the Cheshire Water Company on Kitchen Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30008	Jan. 22	None.	Cons.	.03	3.35	0.85	.0006	.0196	.0062	.0134	.07	.0120	.0000	.10	2.0
31966	July 9	None.	V. slight.	.00	6.10	0.70	.0020	.0020	.0018	.0002	.06	.0070	.0000	.06	5.1
32363	July 31	None.	V. slight.	.00	7.25	0.60	.0100	.0042	.0026	.0016	.10	.0060	.0000	.04	5.3

Odor, none, becoming faintly unpleasant in the first sample, and faintly vegetable in the second sample, on heating.

Chemical Examination of Water from the Cheshire Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
31967	July 9	Slight.	Slight.	.33	14.50	2.80	.0032	.0274	.0248	.0026	.09	.0020	.0000	.49	8.0
32114	July 24	V. slight.	V. slight.	.28	15.00	3.25	.0004	.0176	.0146	.0030	.10	.0000	.0000	.42	9.1
31968	July 9	V. slight.	Slight.	.20	11.05	2.20	.0032	.0258	.0220	.0038	.08	.0010	.0000	.42	8.9
31969	July 9	Slight.	Slight.	.11	9.50	1.65	.0008	.0218	.0178	.0040	.08	.0010	.0000	.34	7.3
32115	July 24	V. slight.	Slight.	.12	9.70	2.00	.0006	.0256	.0196	.0060	.09	.0000	.0002	.40	6.2

Odor of the first, third and fourth samples, faintly vegetable, becoming stronger on heating; of the second, distinctly vegetable; of the last, faintly unpleasant. —— The first two samples were collected from the reservoir, at a road crossing near its upper end; the third, from the reservoir, near the bridge at Farnham's crossing; the last two, from the reservoir, at its outlet. The Cheshire Reservoir is a large and shallow storage reservoir, on the south branch of the Hoosick River, and is not used as a source of public water supply. The examinations of this source were made in connection with an investigation of possible sources of ice supply for the city of North Adams.

Water Supply of Chester.

Chemical Examination of Water from Austin Brook Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
32397	1900. Aug. 7	None.	None.	.09	3.25	0.90	.0004	.0068	.0064	.0004	.10	.0120	.0001	.21	1.1

Odor, faintly vegetable.

Water Supply of Chicopee.

Chemical Examination of Water from Morton Brook Reservoir, Chicopee.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30010	Jan. 22	None.	Slight.	.00	3.35	0.65	.0000	.0032	.0020	.0012	.12	.0110	.0000	.06	0.3
31075	Apr. 24	None.	V. slight.	.01	3.40	0.85	.0000	.0031	.0024	.0007	.12	.0010	.0000	.12	0.8
32325	July 31	V. slight.	V. slight.	.02	3.35	0.75	.0000	.0016	.0016	.0000	.10	.0000	.0000	.11	0.8
33490	Oct. 29	None.	Slight.	.04	3.60	0.60	.0006	.0040	.0034	.0006	.15	.0040	.0000	.07	0.6
Av...	....	....	....	.02	3.42	0.71	.0001	.0030	.0024	.0006	.12	.0040	.0000	.09	0.6

Odor, none, becoming faintly vegetable in the second and last samples on heating.

Chemical Examination of Water from Cooley Brook Reservoir, Chicopee.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30009	Jan. 22	Slight.	Slight.	.78	4.55	1.75	.0018	.0238	.0194	.0044	.12	.0050	.0001	.88	1.0
31074	Apr. 24	V. slight.	Slight.	.71	3.90	1.35	.0006	.0154	.0146	.0008	.12	.0010	.0001	.72	1.0
32324	July 31	V. slight.	V. slight.	.11	3.75	1.00	.0002	.0088	.0048	.0040	.14	.0000	.0002	.21	0.8
33489	Oct. 29	Slight.	V. slight.	.65	4.90	1.60	.0018	.0202	.0186	.0016	.16	.0010	.0000	.79	1.0
Av...	....	....	....	.56	4.27	1.42	.0011	.0171	.0144	.0027	.13	.0017	.0001	.65	0.9

Odor of the first and last samples, none, becoming vegetable on heating; of the second, faintly vegetable; of the third, faintly unpleasant.

CLINTON AND LANCASTER.

Water Supply of Clinton and Lancaster.

Chemical Examination of Water from a Faucet supplied from the Clinton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
32024	1900. July 13	V. slight.	None.	.10	3.90	1.00	.0006	.0098	.0086	.0012	.16	.0060	.0000	.21	1.3

Odor, none.

Water Supply of Cohasset. — Cohasset Water Company.

Chemical Examination of Water from the Tubular Wells of the Cohasset Water Company, situated West of the Main Village.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
30139	1900. Feb. 8	Decided.	V. slight.	.09	14.90	.0004	.0024	1.71	.0400	.0001	.05	6.3	.0660
30929	Apr. 5	V. slight.	V. slight.	.04	13.20	.0004	.0014	1.72	.0290	.0000	.05	5.3	.0160
31528	June 12	V. slight.	V. slight.	.04	13.30	.0006	.0020	1.60	.0230	.0000	.02	6.6	.0210
32612	Aug. 22	V. slight.	None.	.08	13.80	.0004	.0018	1.70	.0300	.0000	.01	5.3	.0220
34243	Dec. 27	V. slight.	V. slight.	.06	11.20	.0006	.0022	1.72	.0480	.0000	.01	6.1	.0280

Averages by Years.

-	1888	-	-	.01	15.20	.0001	.0021	1.50	.0311	.0003	-	-	-
-	1893	-	-	.16	17.14	.0001	.0007	1.64	.0263	.0001	.04	8.6	.0451
-	1894	-	-	.17	17.94	.0004	.0016	1.77	.0204	.0000	.03	8.4	.0743
-	1895	-	-	.19	17.22	.0002	.0015	1.89	.0211	.0000	.03	8.3	.0689
-	1896	-	-	.16	16.10	.0004	.0018	2.05	.0113	.0000	.09	7.9	.0652
-	1897	-	-	.19	15.30	.0005	.0023	2.12	.0267	.0000	.04	6.7	.0333
-	1898	-	-	.07	14.31	.0004	.0019	1.75	.0234	.0000	.03	6.3	.0195
-	1899	-	-	.05	12.60	.0002	.0014	1.75	.0237	.0000	.04	5.8	.0085
-	1900	-	-	.06	13.28	.0005	.0020	1.69	.0340	.0000	.03	5.9	.0306

Note to analyses of 1900: Odor, none. —— The samples were collected from a faucet at the pumping station. These wells formed the original source of supply of the town and have been in use since 1886.

COHASSET.

Chemical Examination of Water from the Tubular Wells of the Cohasset Water Company in Ellms Meadow.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
31529	June 12	None.	None.	.00	20.60	.0000	.0018	1.47	.0840	.0000	.02	8.1	.0030
32613	Aug. 22	None.	None.	.00	14.10	.0000	.0010	1.62	.0870	.0000	.01	4.6	.0050
33390	Oct. 23	None.	None.	.00	12.20	.0002	.0010	1.41	.0650	.0000	.00	5.6	.0080
Av...	....	....	....	.00	15.63	.0001	.0013	1.50	.0787	.0000	.01	6.1	.0053

Odor, none.——The samples were collected from a faucet at the Ellms Meadow pumping station. These wells are used as an auxiliary source of supply chiefly in the summer season.

Water Supply of Concord and Lincoln.

Chemical Examination of Water from Sandy Pond, Lincoln.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
29883	Jan. 8	V. slight.	None.	.00	2.40	1.00	.0016	.0144	.0140	.0004	.30	.0020	.0000	.16	0.3
31521	June 11	None.	V. slight.	.02	2.65	0.85	.0004	.0138	.0130	.0008	.27	.0010	.0000	.22	0.2
32592	Aug. 22	V. slight.	Slight.	.03	2.35	0.90	.0010	.0184	.0166	.0018	.26	.0020	.0000	.19	0.2
33426	Oct. 24	None.	None.	.02	2.90	0.75	.0040	.0192	.0176	.0016	.29	.0010	.0000	.12	0.2
34210	Dec. 24	None.	V. slight.	.00	2.25	0.80	.0016	.0142	.0132	.0010	.26	.0010	.0000	.13	0.5
Av...	....	....	....	.01	2.51	0.86	.0017	.0160	.0149	.0011	.28	.0014	.0000	.16	0.3

Odor, none. A faintly vegetable odor was developed in the second and third samples on heating. ——The samples were collected from the pond.

CONCORD AND LINCOLN.

The advice of the State Board of Health to George E. Russell and others, relative to the use of ice from Warner's Pond at Concord Junction for domestic purposes, may be found on page 94 of this volume. The results of an analysis of a sample of water collected from the pond are given in the following table: —

Chemical Examination of Water from Warner's Pond, Concord.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
29950	1900. Jan. 15	V. slight.	V. slight.	.36	4.40	1.60	.0034	.0220	.0194	.0026	.240	.0070	.0001	.63	1.3

Odor, none, becoming faintly vegetable on heating. —— The sample was collected from the southeasterly portion of the pond, near the bridge leading to an island in the pond.

The advice of the State Board of Health to the superintendent of the Massachusetts Reformatory at Concord, relative to certain proposed sources of water supply for that institution, may be found on page 28 of this volume. The results of analyses of samples of water collected from tubular wells near the Reformatory and from Nashoba Brook are given in the following table: —

Chemical Examination of Water from Tubular Test Wells near the Massachusetts Reformatory and from Nashoba Brook, Concord.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
31050	1900. Apr. 20	Decided.	Cons.	.28	9.50	.0010	.0010	.24	.0020	.0000	0.12	1.4	.1400
31160	May 4	Decided.	Slight.	.90	8.00	.0036	.0014	.25	.0010	.0001	0.10	2.0	.2400
31049	Apr. 20	V. slight.	V. slight.	.85	4.25	.0000	.0248	.22	.0020	.0000	1.04	0.6	–

Odor of No. 31050, none; of No. 31049, none, becoming faintly vegetable on heating; of No. 31160, faintly unpleasant. —— The first two samples were collected from a driven well situated about 1,000 feet west of the Reformatory between the highway and the northern division of the New York, New Haven & Hartford Railroad, and 500 feet from the edge of Warner's Pond; the last, from Nashoba Brook, at the point where it is crossed by the road from Concord to West Acton.

COTTAGE CITY.

Water Supply of Cottage City. — Cottage City Water Company.

Chemical Examination of Water from the Springs of the Cottage City Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
32031	July 13	None.	V. slight.	.00	4.10	.0004	.0008	.94	.0110	.0000	.03	0.5	.0090
32400	Aug. 6	None.	V. slight.	.00	3.70	.0000	.0020	.91	.0070	.0000	.02	0.3	.0060

Odor, none. —— The samples were collected from a faucet at the pumping station.

Water Supply of Danvers and Middleton.

Chemical Examination of Water from Middleton Pond, Middleton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30438	Mar. 12	V. slight.	V. slight.	.40	3.45	1.50	.0000	.0160	.0146	.0014	.31	.0010	.0000	.63	1.0
31514	June 11	V. slight.	V. slight.	.62	3.90	1.50	.0014	.0194	.0188	.0006	.34	.0020	.0000	.81	1.0
32945	Sept. 17	Slight.	Slight.	.42	3.65	1.15	.0004	.0176	.0164	.0012	.34	.0010	.0000	.56	1.3
33983	Dec. 10	V. slight.	V. slight.	.36	3.65	1.10	.0016	.0190	.0162	.0028	.33	.0050	.0000	.60	1.6
Av...	....	....	....	.45	3.66	1.31	.0008	.0180	.0165	.0015	.33	.0022	.0000	.65	1.2

Odor, faintly vegetable or unpleasant, becoming stronger on heating. —— The samples were collected from a faucet at the pumping station.

Dartmouth.

The advice of the State Board of Health to Franklyn Howland of New Bedford, relative to the water supply of the small summer settlement of Bay View, in Dartmouth, may be found on page 11 of this volume. The results of an analysis of a sample of water collected from the well which forms the principal source of supply of the settlement may be found on page 178 of the annual report for 1899.

DEDHAM.

Water Supply of Dedham. — Dedham Water Company.

Chemical Examination of Water from the Large Well of the Dedham Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1900.												
29845	Jan. 3	None.	None.	.00	10.20	.0006	.0038	0.83	.2000	.0000	.07	3.8	.0040
30126	Feb. 5	None.	None.	.00	10.30	.0010	.0028	0.91	.2400	.0000	.04	3.9	.0040
30385	Mar. 6	None.	None.	.00	10.00	.0000	.0032	0.87	.2600	.0000	.04	4.2	.0010
30921	Apr. 4	None.	None.	.00	9.90	.0002	.0014	0.96	.2960	.0000	.03	4.4	.0010
31149	May 2	None.	None.	.00	10.00	.0010	.0052	0.90	.2500	.0000	.01	3.8	.0010
31444	June 5	None.	V. slight.	.00	10.20	.0006	.0036	0.89	.2600	.0000	.05	4.2	.0070
32392	Aug. 7	None.	None.	.02	7.70	.0020	.0086	0.59	.0800	.0000	.10	3.1	.0090
32781	Sept. 4	None.	None.	.00	7.40	.0010	.0026	0.58	.0860	.0000	.08	3.0	.0040
33140	Oct. 1	None.	None.	.00	10.90	.0012	.0038	0.90	.2050	0000	.00	3.4	.0050
33600	Nov. 7	None.	None.	.00	11.40	.0008	.0070	1.02	.2450	.0000	.03	4.0	.0010
33913	Dec. 4	None.	None.	.00	9.60	.0010	.0048	0.85	.2400	.0000	.01	3.9	.0060

Averages by Years.

-	1892	-	-	.00	10.65	.0000	.0006	0.95	.2982	.0000	-	4.4	.0007
-	1893	-	-	.00	10.14	.0000	.0024	0.92	.2325	.0000	.08	4.2	.0000
-	1894	-	-	.01	10.18	.0000	.0017	0.86	.2008	.0000	.03	4.0	.0013
-	1895	-	-	.02	9.92	.0009	.0015	0.85	.1768	.0000	.04	3.9	.0000
-	1896	-	-	.01	9.30	.0001	.0023	0.82	.1205	.0000	.04	3.9	.0012
-	1897	-	-	.01	9.42	.0008	.0031	0.84	.1750	.0000	.03	4.3	.0015
-	1898	-	-	.02	9.48	.0005	.0033	0.82	.1895	.0000	.05	3.9	.0020
-	1899	-	-	.01	9.72	.0007	.0042	0.84	.2142	.0000	.04	3.7	.0043
-	1900	-	-	.00	9.78	.0009	.0043	0.85	.2147	.0000	.04	3.8	.0039

Note to analyses of 1900: Odor, none. —— No. 30126 was collected from a faucet at the pumping station; the others, from the well.

DEDHAM.

Chemical Examination of Water from the Tubular Well of the Dedham Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29846	Jan. 3	None.	None.	.00	12.10	.0000	.0012	1.08	.4100	.0001	.03	4.3	.0020
30125	Feb. 5	None.	None.	.00	11.90	.0002	.0022	1.10	.3900	.0000	.02	4.3	.0040
30386	Mar. 6	None.	None.	.00	12.10	.0000	.0010	1.06	.3700	.0000	.03	4.9	.0020
30922	Apr. 4	None.	None.	.00	11.60	.0000	.0006	1.14	.4200	.0001	.02	5.0	.0030
31150	May 2	None.	None.	.00	11.80	.0000	.0006	1.06	.3800	.0000	.01	4.3	.0010
31445	June 5	None.	None.	.00	12.40	.0004	.0006	1.09	.3650	.0000	.02	4.7	.0040
32009	July 12	None.	None.	.00	12.00	.0006	.0010	1.09	.4100	.0002	.01	4.9	.0070
32393	Aug. 7	None.	None.	.00	12.90	.0000	.0006	1.12	.3600	.0002	.03	4.6	.0040
32782	Sept. 4	None.	Slight.	.00	13.30	.0000	.0006	1.10	.3350	.0001	.01	4.4	.0050
33141	Oct. 1	None.	None.	.00	12.80	.0000	.0008	1.15	.3500	.0001	.00	4.9	.0040
33601	Nov. 7	None.	None.	.00	12.70	.0004	.0020	1.14	.3900	.0000	.01	4.3	.0020
33914	Dec. 4	None.	V. slight.	.00	12.10	.0000	.0010	1.11	.2350	.0000	.01	5.0	.0050
Av...	....	....	....	.00	12.31	.0001	.0010	1.10	.3679	.0001	.02	4.6	.0036

Odor, none.——The samples were collected from the 6-inch driven well located near the large well.

Water Supply of Dracut. — American Woolen Company.

During the year 1900, works for the supply of the village of Collinsville in Dracut were constructed by the American Woolen Company. The source of supply is a system of eight tubular wells, driven in the valley of Double Brook about 1,000 feet below Long Pond. The wells are driven in a line approximately parallel to the brook, the distance between the wells on either end of the line being about 350 feet. The wells are 2½ inches in diameter, and are driven to a depth of about 20 feet. Water flows by gravity from the wells to the factory of the American Woolen Company, where it is pumped to an open iron tank 25 feet in diameter and 35 feet high, from which it is distributed to the village.

The advice of the State Board of Health to the American Woolen Company, relative to a supply of water for the village of Collinsville, to be taken from tubular wells in the valley of Double Brook, may be found on page 13 of this volume. The results of analyses

DRACUT.

of samples of water collected from the various test wells in the valley of the brook are given in the following table: —

Chemical Examination of Water from Tubular Test Wells at Dracut.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29983	Jan. 18	Decided.	Cons.	.01	4.00	.0000	.0010	.23	.0060	.0000	.03	1.1	.0200
29984	Jan. 18	Decided.	Cons.	.00	4.30	.0000	.0010	.23	.0060	.0000	.04	1.1	.0110
29985	Jan. 18	Decided.	Cons.	.00	4.60	.0000	.0008	.23	.0060	.0000	.03	1.1	.0090
29986	Jan. 18	Decided.	Slight.	.01	4.90	.0000	.0004	.23	.0070	.0000	.03	1.1	.0100
29987	Jan. 18	Decided.	Cons.	.03	5.50	.0000	.0008	.23	.0070	.0000	.03	1.3	.0140
29988	Jan. 18	Decided.	Cons.	.03	5.20	.0000	.0004	.23	.0070	.0000	.03	1.3	.0090
29989	Jan. 18	V. slight.	V. slight.	.00	4.90	.0000	.0006	.23	.0070	.0000	.03	1.3	.0050
	1899.												
29556	Dec. 1	Decided.	Slight.	.13	5.00	.0000	.0010	.22	.0060	.0000	.03	1.8	.0040

Odor, none. —— The samples were collected from tubular test wells in the valley of Double Brook, about 1,000 feet below Long Pond. The wells are located in a line approximately parallel to the brook, 300 feet in length, and the first sample was collected from the last or most southerly well in the line, and the last from the upper or most northerly well.

Water Supply of East Bridgewater.

(See *Bridgewater*.)

Water Supply of Easthampton.

Chemical Examination of Water from Bassett Brook, Easthampton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30913	Apr. 3	V. slight.	V. slight.	.17	2.85	0.90	.0002	.0082	.0076	.0006	.08	.0050	.0001	.32	0.8
31900	June 30	V. slight.	Slight.	.36	4.45	1.10	.0026	.0154	.0134	.0020	.12	.0010	.0002	.43	1.3
33116	Sept. 27	V. slight.	V. slight.	.14	4.20	0.95	.0000	.0064	.0058	.0006	.11	.0020	.0000	.19	1.7
	1901.														
34376	Jan. 8	V. slight.	None.	.08	3.50	1.05	.0008	.0052	.0040	.0012	.10	.0100	.0000	.16	1.3
Av...	....	....	....	.19	3.75	1.00	.0009	.0088	.0077	.0011	.10	.0045	.0001	.27	1.3

Odor of the second sample, faintly vegetable, becoming stronger on heating; of the others, none. —— The first sample was collected from the reservoir; the others, from a faucet.

EASTON.

Water Supply of North Easton Village District, Easton.

Chemical Examination of Water from the Well of the North Easton Village District.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid		Nitrates.	Nitrites.			
	1900.												
32421	Aug. 7	None.	None.	.00	3.90	.0000	.0010	.50	.0370	.0000	.03	1.3	.0030
32838	Sept. 5	None.	None.	.00	4.40	.0002	.0012	.47	.0320	.0000	.01	1.1	.0020

Odor, none.

Water Supply of Everett.

(See *Metropolitan Water District*, pages 109–128.)

Water Supply of Fairhaven. — Fairhaven Water Company.

Chemical Examination of Water from the Tubular Wells of the Fairhaven Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1900.												
30235	Feb. 19	None.	None.	.02	4.40	.0002	.0026	0.75	.0250	.0000	0.12	1.1	.0130
31051	Apr. 18	None.	None.	.03	4.30	.0000	.0014	0.73	.0380	.0001	0.14	1.4	.0100
31832	June 22	V. slight.	None.	.10	5.50	.0002	.0050	0.75	.0390	.0001	0.19	1.4	.0030
32642	Aug. 22	None.	Slight.	.00	5.50	.0000	.0010	0.73	.0420	.0000	0.06	1.4	.0080
33410	Oct. 23	None.	None.	.60	10.20	.0010	.0250	1.04	.0280	.0000	1.31	2.6	.0180
	1901.												
34337	Jan. 3	None.	V. slight.	.13	5.80	.0002	.0054	0.90	.0510	.0002	0.15	1.6	.0260

Averages by Years.

-	1894	-	-	.04	6.19	.0004	.0024	0.98	.0903	.0002	0.07	1.8	.0138
-	1895	-	-	.13	5.52	.0001	.0042	1.02	.0587	.0001	0.20	1.7	.0076
-	1896	-	-	.28	6.02	.0004	.0055	1.01	.0366	.0000	0.32	1.9	.0116
-	1897	-	-	.18	5.56	.0005	.0044	1.01	.0361	.0001	0.19	1.9	.0143
-	1898	-	-	.16	5.33	.0002	.0042	0.83	.0362	.0001	0.20	1.7	.0088
-	1899	-	-	.20	5.28	.0003	.0056	0.67	.0288	.0001	0.30	1.3	.0100
-	1900	-	-	.15	5.95	.0003	.0067	0.82	.0372	.0001	0.33	1.6	.0130

Note to analyses of 1900: Odor, none. —— The samples were collected from a faucet at the pumping station.

FALL RIVER.

Water Supply of Fall River.

Chemical Examination of Water from North Watuppa Lake.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29941	Jan. 15	Slight.	Slight.	.09	3.35	1.30	.0012	.0252	.0220	.0032	.55	.0010	.0001	.30	0.3
30230	Feb. 19	Slight.	Cons.	.11	3.30	1.45	.0004	.0248	.0224	.0024	.47	.0010	.0000	.39	0.2
30625	Mar. 19	V. slight.	Slight.	.17	3.20	1.30	.0004	.0206	.0174	.0032	.50	.0010	.0000	.39	0.3
31013	Apr. 16	V. slight.	Slight.	.12	3.35	1.35	.0006	.0234	.0204	.0030	.51	.0010	.0000	.44	0.6
31237	May 14	V. slight.	Slight.	.18	3.25	1.00	.0020	.0198	.0180	.0018	.49	.0020	.0000	.45	0.5
31723	June 18	Slight.	Slight.	.21	3.50	1.15	.0014	.0248	.0224	.0024	.53	.0010	.0000	.50	0.6
32296	July 30	Slight.	Cons.	.10	3.15	1.00	.0002	.0194	.0180	.0014	.51	.0010	.0000	.40	0.3
32665	Aug. 27	V. slight.	Cons.	.10	3.55	0.95	.0004	.0218	.0182	.0036	.54	.0010	.0000	.31	0.5
33049	Sept. 24	Slight.	Slight.	.12	3.35	1.00	.0000	.0182	.0160	.0022	.56	.0010	.0000	.31	0.3
33451	Oct. 25	V. slight.	Cons.	.11	3.50	1.20	.0008	.0192	.0184	.0008	.58	.0010	.0000	.26	0.2
33800	Nov. 26	V. slight.	V. slight.	.11	3.15	0.85	.0012	.0156	.0150	.0006	.56	.0020	.0000	.31	0.5
34222	Dec. 26	None.	V. slight.	.09	3.20	1.15	.0016	.0176	.0166	.0010	.56	.0030	.0001	.36	0.3

Averages by Years.

-	1888	-	-	.17	3.18	0.93	.0004	.0158	-	-	.52	.0057	.0001	-	-
-	1892	-	-	.08	2.95	0.86	.0012	.0130	.0107	.0023	.52	.0117	.0001	-	0.5
-	1896	-	-	.22	3.32	1.14	.0011	.0160	.0137	.0023	.61	.0041	.0000	.35	0.7
-	1897	-	-	.23	3.50	1.17	.0010	.0144	.0138	.0006	.63	.0032	.0000	.35	0.7
-	1898	-	-	.31	3.45	1.44	.0011	.0194	.0171	.0023	.58	.0024	.0000	.44	0.8
-	1899	-	-	.20	3.29	1.42	.0012	.0207	.0180	.0027	.48	.0026	.0000	.40	0.5
-	1900	-	-	.13	3.32	1.14	.0008	.0208	.0187	.0021	.53	.0013	.0000	.37	0.4

Note to analyses of 1900: Odor, faintly vegetable or none. A distinctly fishy odor was developed in No. 30625 on heating.

Microscopical Examination of Water from North Watuppa Lake.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	16	20	20	17	15	19	31	28	25	26	27	27
Number of sample,	29941	30230	30625	31013	31237	31723	32296	32665	33049	33451	33800	34222
PLANTS.												
Diatomaceæ,	123	405	528	483	3	5	2	0	0	11	1	14
Asterionella,	0	0	0	102	0	0	0	0	0	0	0	10
Cyclotella,	95	160	36	0	3	0	0	0	0	0	0	0
Synedra,	13	167	414	370	0	4	2	0	0	3	1	4
Tabellaria,	15	57	78	11	0	1	0	0	0	4	0	0
Cyanophyceæ,	0	0	0	0	0	40	7	47	10	9	0	0
Merismopœdia,	0	0	0	0	0	40	5	47	0	0	0	0
Microcystis,	0	0	0	0	0	0	0	0	10	9	0	0
Algæ,	44	61	80	57	0	75	38	15	0	16	0	0
Protococcus,	40	58	76	55	0	73	36	15	0	0	0	0

FALL RIVER.

Microscopical Examination of Water from North Watuppa Lake — Concluded.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.												
Infusoria,	1	53	376	135	0	0	0	0	0	0	0	0
Dinobryon,	0	53	376	135	0	0	0	0	0	0	0	0
Crustacea, Cyclops,	pr.	0	0	0	0	pr.	0	0	pr.	0	pr.	
Miscellaneous, Zoöglœa,	5	7	10	5	3	8	5	3	15	5	5	5
TOTAL,	173	526	994	680	6	128	52	65	25	41	6	19

Chemical Examination of Water from South Watuppa Lake.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
29942	Jan. 15	Decided.	Slight.	.22	6.00	1.50	.0010	.0238	.0212	.0026	.85	.0010	.0001	.38	2.0
30231	Feb. 19	Slight.	Cons.	.12	3.45	1.40	.0002	.0184	.0162	.0022	.47	.0010	.0000	.38	0.3
30626	Mar. 19	V. slight.	Slight.	.20	3.25	1.40	.0010	.0234	.0202	.0032	.55	.0010	.0000	.40	0.3
31012	Apr. 16	V. slight.	Slight.	.15	3.95	1.50	.0004	.0224	.0194	.0030	.59	.0020	.0000	.43	0.8
31238	May 14	Slight.	Slight.	.20	3.55	1.00	.0034	.0190	.0166	.0024	.53	.0010	.0001	.50	0.5
31724	June 18	V. slight.	V. slight.	.24	5.10	1.50	.0036	.0212	.0198	.0014	.86	.0030	.0000	.47	2.0
32297	July 30	Slight.	Cons.	.14	5.10	1.40	.0012	.0234	.0192	.0042	.68	.0010	.0001	.39	1.1
32666	Aug. 27	Slight.	Slight.	.14	3.60	1.00	.0010	.0216	.0196	.0020	.51	.0010	.0000	.33	0.8
33050	Sept. 24	V. slight.	V. slight.	.17	6.90	1.50	.0024	.0196	.0182	.0014	.93	.0020	.0000	.34	1.8
33450	Oct. 25	V. slight.	Slight.	.13	3.70	0.90	.0004	.0206	.0186	.0020	.63	.0030	.0001	.28	0.6
33801	Nov. 26	Decided.	Cons.	.30	3.55	1.00	.0020	.0180	.0164	.0016	.59	.0050	.0000	.36	0.6
34223	Dec. 26	V. slight.	V. slight.	.14	4.55	1.20	.0042	.0208	.0186	.0022	.98	.0030	.0001	.44	2.0
Av...	....	....	....	.18	4.39	1.27	.0017	.0210	.0187	.0023	.68	.0020	.0000	.39	1.1

Odor of No. 33801, faintly unpleasant; of the others, generally faintly vegetable or none. On heating, the odor of all of the samples became vegetable or unpleasant, and in March, fishy. This lake is not used as a source of water supply.

FALL RIVER.

Microscopical Examination of Water from South Watuppa Lake.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	16	20	20	17	15	19	31	28	25	26	27	27
Number of sample,	29942	30231	30626	31012	31238	31724	32297	32666	33050	33450	33801	34223
PLANTS.												
Diatomaceæ,	51	301	348	564	5	17	6	3	5	4	7	6
Asterionella,	10	0	32	523	4	3	0	0	0	1	0	5
Cyclotella,	38	74	88	26	0	10	0	0	0	0	1	1
Synedra,	3	219	168	7	0	2	0	0	2	0	4	0
Tabellaria,	0	0	60	8	1	1	6	3	3	0	1	0
Cyanophyceæ,	0	0	0	0	0	0	13	4	0	0	0	0
Algæ,	0	59	112	1	12	39	81	46	2	0	0	0
Protococcus,	0	58	110	0	10	39	79	45	0	0	0	0
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	1	0	0	0	0	0	0	0	0
Infusoria,	3	30	238	121	1	0	0	1	1	0	0	0
Dinobryon,	0	28	238	121	0	0	0	0	0	0	0	0
Vermes, Rotifer,	0	0	2	0	0	0	0	0	0	0	0	0
Crustacea, Cyclops,	0	0	0	0	0	0	0	0	0	0	0	pr.
Miscellaneous, Zoöglœa,	5	7	8	5	5	5	5	5	5	5	7	3
TOTAL,	59	397	708	692	23	61	105	59	13	9	14	9

FALMOUTH.

WATER SUPPLY OF FALMOUTH. — FALMOUTH WATER COMPANY.

Chemical Examination of Water from the Wells of the Falmouth Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1900.												
30012	Jan. 22	None.	V. slight.	.00	2.70	.0000	.0080	.92	.0010	.0000	.08	0.2	.0010
30320	Feb. 26	None.	V. slight.	.07	2.90	.0004	.0086	.89	.0000	.0000	.09	0.2	.0110
30689	Mar. 21	None.	None.	.00	2.40	.0000	.0086	.91	.0010	.0000	.07	0.2	.0020
31104	Apr. 26	None.	V. slight.	.00	3.00	.0006	.0066	.92	.0010	.0000	.08	0.2	.0050
31358	May 21	None.	V. slight.	.00	2.60	.0016	.0084	.90	.0020	.0000	.06	0.2	.0030
31848	June 25	None.	None.	.00	2.80	.0000	.0100	.91	.0010	.0000	.02	0.0	.0030
32150	July 23	None.	None.	.00	2.50	.0000	.0094	.96	.0000	.0000	.02	0.0	.0000
32690	Aug. 27	None.	V. slight.	.00	3.20	.0002	.0100	.93	.0030	.0000	.06	0.2	.0020
33106	Sept. 24	None.	V. slight.	.00	3.00	.0002	.0092	.92	.0010	.0000	.09	0.2	.0050
33464	Oct. 24	None.	V. slight.	.03	3.60	.0000	.0102	.92	.0010	.0001	.08	0.0	.0040
33874	Nov. 26	None.	V. slight.	.02	2.50	.0006	.0086	.93	.0030	.0000	.05	0.3	.0100
	1901.												
34309	Jan. 1	None.	V. slight.	.00	2.70	.0000	.0090	.92	.0030	.0000	.02	0.0	.0050
Av...	....	....	....	.01	2.82	.0003	.0089	.92	.0014	.0000	.06	0.1	.0042

Odor, none. A distinctly vegetable odor was developed in No. 30320, and a faintly unpleasant odor in No. 33874, on heating. —— The samples were collected from a faucet at the pumping station.

WATER SUPPLY OF FITCHBURG.

Chemical Examination of Water from Scott Reservoir, Fitchburg.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
29978	Jan. 17	Decided.	Slight.	.14	3.10	0.95	.0250	.0126	.0104	.0022	.20	.0050	.0003	.19	0.3
31026	Apr. 17	V. slight.	Slight.	.11	1.75	0.65	.0000	.0138	.0118	.0020	.10	.0020	.0000	.32	0.0
32357	Aug. 1	Slight.	Slight.	.09	2.50	1.10	.0004	.0312	.0254	.0058	.11	.0000	.0000	.33	0.2
33398	Oct. 23	Slight.	Cons.	.29	3.10	0.85	.0020	.0332	.0192	.0140	.17	.0010	.0000	.37	0.2
Av...	....	....	....	.16	2.61	0.89	.0068	.0227	.0167	.0060	.14	.0020	.0001	.30	0.2

Odor of the first two samples, none, becoming faintly vegetable on heating; of the last two, unpleasant.

FITCHBURG.

Chemical Examination of Water from Meetinghouse Pond, Westminster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29979	Jan. 17	V. slight.	V. slight.	.05	2.65	0.90	.0012	.0128	.0124	.0004	.20	.0010	.0000	.19	0.6
31025	Apr. 17	V. slight.	Slight.	.07	2.45	0.85	.0010	.0128	.0110	.0018	.14	.0010	.0000	.24	0.6
32356	Aug. 1	Slight.	Cons.	.02	2.50	1.00	.0014	.0198	.0128	.0070	.13	.0010	.0000	.20	0.3
33395	Oct. 23	None.	Slight.	.04	2.65	0.60	.0008	.0140	.0128	.0012	.13	.0020	.0000	.19	0.6
Av...	....	....	....	.04	2.56	0.84	.0011	.0148	.0122	.0026	.15	.0012	.0000	.20	0.5

Odor of the first two samples, faintly vegetable; of the third, very faintly unpleasant; of the last, none.

Water Supply of Foxborough Water Supply District, Foxborough.

Chemical Examination of Water from the Tubular Wells of the Foxborough Water Supply District.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
32826	Sept. 5	None.	None.	.00	3.20	.0000	.0002	.36	.0400	.0000	.00	0.5	.0040

Odor, none. — The samples were collected from a faucet at the pumping station.

Water Supply of Framingham. — Framingham Water Company.

Chemical Examination of Water from the Filter-gallery of the Framingham Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29874	Jan. 8	None.	None.	.00	7.00	.0040	.0044	.89	.0280	.0001	.08	3.4	.0090
30439	Mar. 12	None.	None.	.01	7.20	.0036	.0038	.82	.0430	.0004	.07	3.3	.0070
31212	May 7	None.	V. slight.	.01	7.60	.0024	.0036	.81	.0240	.0001	.06	3.4	.0110
31952	July 9	None.	None.	.02	7.70	.0022	.0032	.82	.0300	.0002	.03	3.3	.0050
32875	Sept. 10	V. slight.	V. slight.	.10	7.20	.0028	.0042	.82	.0200	.0007	.06	3.3	.0460
33643	Nov. 12	V. slight.	V. slight.	.06	7.50	.0032	.0098	.86	.0200	.0003	.12	3.0	.0100

FRAMINGHAM.

Chemical Examination of Water from the Filter-gallery of the Framingham Water Company — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
-	1888	-	-	.10	5.81	.0027	.0081	0.44	.0308	.0004	-	-	-
-	1889	-	-	.00	6.18	.0031	.0050	0.56	.0366	.0002	-	-	-
-	1890	-	-	.00	7.09	.0020	.0039	0.65	.0631	.0001	-	3.0	-
-	1891	-	-	.00	6.25	.0023	.0035	0.63	.0707	.0001	-	2.8	-
-	1893	-	-	.04	6.07	.0026	.0033	0.62	.0460	.0001	.11	2.6	.0099
-	1894	-	-	.03	6.75	.0025	.0043	0.79	.0515	.0001	.08	2.8	.0272
-	1895	-	-	.04	7.32	.0020	.0049	0.92	.0230	.0000	.07	3.0	.0130
-	1896	-	-	.04	7.37	.0022	.0040	0.91	.0317	.0002	.04	3.2	.0145
-	1897	-	-	.04	7.00	.0021	.0076	1.00	.0245	.0001	.06	3.3	.0072
-	1898	-	-	.05	7.46	.0030	.0065	0.90	.0303	.0001	.09	3.2	.0090
-	1899	-	-	.02	7.57	.0030	.0044	0.85	.0382	.0003	.05	3.2	.0047
-	1900	-	-	.03	7.37	.0030	.0048	0.84	.0275	.0003	.07	3.3	.0147

NOTE to analyses of 1900: Odor, none.

WATER SUPPLY OF FRANKLIN. — FRANKLIN WATER COMPANY.

Chemical Examination of Water from the Wells of the Franklin Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Nitrogen as		Chlorine.	Ammonia.		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30129	Feb. 7	V. slight.	V. slight.	.00	10.70	.0002	.0010	1.00	.4000	.0000	.04	3.9	.0190
30916	Apr. 4	V. slight.	V. slight.	.18	6.30	.0002	.0064	0.52	.1400	.0000	.19	2.2	.0150
31474	June 6	None.	V. slight.	.03	9.50	.0012	.0038	0.83	.2560	.0000	.04	3.2	.0220
32389	Aug. 7	Slight.	V. slight.	.40	5.20	.0012	.0150	0.45	.0720	.0004	.52	1.4	.0220
33164	Oct. 2	V. slight.	V. slight.	.28	6.40	.0008	.0144	0.62	.0820	.0000	.41	1.7	.0130
33915	Dec. 4	V. slight.	V. slight.	.22	7.50	.0018	.0110	0.73	.1800	.0001	.30	3.0	.0120
Av...	....	....	....	.18	7.60	.0009	.0086	0.69	.1883	.0001	.25	2.6	.0172

Odor, none. —— Nos. 30129 and 31474 were collected from the wells; the others, from a faucet at the office of the water company. The samples, excepting the first, probably contain surface water drawn from Beaver Pond, which is under the control of the company.

GARDNER.

WATER SUPPLY OF GARDNER. — GARDNER WATER COMPANY.

Chemical Examination of Water from Crystal Lake, Gardner.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
30405	Mar. 7	Decided.	Slight.	.10	3.15	1.25	.0008	.0230	.0166	.0064	.29	.0040	.0003	.26	0.8
31483	June 6	V. slight.	V. slight.	.03	3.10	0.85	.0024	.0182	.0164	.0018	.29	.0050	.0000	.20	0.8
32830	Sept. 5	V. slight.	V. slight.	.07	3.20	1.10	.0006	.0182	.0156	.0026	.31	.0010	.0000	.21	0.6
34090	Dec. 14	V. slight.	V. slight.	.06	3.00	0.90	.0022	.0148	.0132	.0016	.33	.0220	.0001	.19	1.4

Averages by Years.

-	1893	-	-	.05	2.65	0.82	.0012	.0126	.0105	.0021	.27	.0021	.0000	.19	0.8
-	1894	-	-	.04	2.75	0.98	.0009	.0111	.0094	.0017	.31	.0023	.0000	.15	1.0
-	1895	-	-	.05	2.75	0.97	.0008	.0192	.0170	.0022	.34	.0020	.0000	.17	1.2
-	1896	-	-	.06	3.07	0.94	.0020	.0156	.0120	.0036	.33	.0050	.0000	.18	1.1
-	1897	-	-	.12	3.31	1.04	.0010	.0176	.0145	.0031	.38	.0096	.0000	.19	1.0
-	1898	-	-	.08	3.46	1.31	.0014	.0152	.0133	.0019	.37	.0082	.0000	.23	1.2
-	1899	-	-	.06	3.11	1.10	.0021	.0187	.0175	.0012	.33	.0070	.0001	.23	0.9
-	1900	-	-	.06	3.11	1.02	.0015	.0185	.0154	.0031	.30	.0080	.0001	.21	0.9

NOTE to analyses of 1900: Odor of the first sample, faintly unpleasant, becoming also fishy on heating; of the last three, none. —— No. 34090 was collected from a tap; the others, from the lake.

WATER SUPPLY OF GLOUCESTER.

The advice of the State Board of Health to the city of Gloucester, relative to an additional water supply for that city, may be found on page 14 of this volume. The results of analyses of samples of water collected from various sources during the investigations are given in one of the following tables: —

GLOUCESTER.

Chemical Examination of Water from Dike's Brook Storage Reservoir, Gloucester.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30324	Feb. 27	V. slight.	V. slight.	.50	4.10	1.65	.0006	.0204	.0142	.0062	.86	.0050	.0000	.50	0.2
31082	Apr. 25	V. slight.	Cons.	.25	3.80	1.10	.0000	.0174	.0154	.0020	.82	.0010	.0000	.33	0.2
31879	June 27	V. slight.	Slight.	.23	3.75	1.15	.0014	.0180	.0154	.0026	.83	.0010	.0000	.38	0.2
32104	July 20	V. slight.	Slight.	.23	3.25	0.90	.0018	.0210	.0152	.0058	.84	.0000	.0001	.41	0.2
32719	Aug. 29	V. slight.	V. slight.	.20	4.10	1.10	.0006	.0204	.0180	.0024	.90	.0020	.0000	.42	0.0
33518	Oct. 30	Slight.	Slight.	.48	4.90	1.70	.0020	.0300	.0212	.0088	.91	.0010	.0000	.52	0.2
34251	Dec. 27	Slight.	Slight.	.40	4.00	1.85	.0024	.0262	.0180	.0082	.97	.0050	.0002	.55	0.3

Averages by Years.

-	1888	-	-	.47	4.35	1.74	.0077	.0243	-	-	.72	.0058	.0002	-	-
-	1889	-	-	.66	-	-	.0073	.0223	-	-	.76	.0042	.0001	-	-
-	1890	-	-	.46	4.36	1.52	.0048	.0190	.0155	.0035	.73	.0070	.0001	-	1.2
-	1891	-	-	.48	4.11	1.48	.0010	.0196	.0160	.0036	.75	.0098	.0001	-	0.6
-	1892	-	-	.49	4.32	1.58	.0019	.0197	.0163	.0034	.90	.0126	.0001	-	0.7
-	1894	-	-	.50	3.93	1.29	.0034	.0177	.0153	.0024	.98	.0023	.0000	.43	0.3
-	1895	-	-	.46	4.24	1.58	.0029	.0202	.0173	.0029	.96	.0054	.0000	.49	0.3
-	1896	-	-	.34	3.90	1.35	.0032	.0150	.0134	.0016	.83	.0020	.0000	.40	0.5
-	1897	-	-	.46	4.16	1.57	.0017	.0199	.0169	.0030	.93	.0037	.0000	.41	0.5
-	1898	-	-	.36	3.76	1.50	.0018	.0182	.0143	.0039	.84	.0037	.0000	.41	0.4
-	1899	-	-	.40	3.94	1.59	.0072	.0209	.0184	.0025	.86	.0029	.0000	.43	0.3
-	1900	-	-	.33	3.99	1.35	.0013	.0219	.0168	.0051	.88	.0021	.0000	.44	0.2

NOTE to analyses of 1900: Odor of the first two and last samples, unpleasant; of the others, none. A fishy odor was developed in most of the samples on heating.

Microscopical Examination of Water from Dike's Brook Storage Reservoir, Gloucester.

[Number of organisms per cubic centimeter.]

	1900. Feb.	Apr.	June.	July.	Aug.	Oct.	Dec.
Day of examination,	28	26	28	23	30	31	29
Number of sample,	30324	31082	31879	32104	32719	33518	34251
PLANTS.							
Diatomaceæ,	1	0	0	2	81	0	123
Synedra,	0	0	0	2	80	0	112
Algæ,	0	0	836	2	0	0	0
Protococcus,	0	0	836	0	0	0	0

GLOUCESTER.

Microscopical Examination of Water from Dike's Brook Storage Reservoir, Gloucester — Concluded.

[Number of organisms per cubic centimeter.]

	1900.						
	Feb.	Apr.	June.	July.	Aug.	Oct.	Dec.
ANIMALS.							
Infusoria,	140	36	0	2	46	94	80
Dinobryon,	74	17	0	0	0	0	20
Peridinium,	46	7	0	0	46	86	54
Uroglena,	13	10	0	0	0	0	0
Vermes,	0	0	0	1	0	0	5
Anurea,	0	0	0	0	0	0	5
Miscellaneous, Zoöglœa,	5	7	3	8	3	3	3
Total,	146	43	839	15	130	97	211

Chemical Examination of Water from Wallace Pond, Gloucester.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30325	Feb. 27	V. slight.	V. slight.	.42	4.85	1.55	.0098	.0202	.0142	.0060	1.25	.0020	.0000	.49	0.2
31083	Apr. 25	V. slight.	Cons.	.20	3.80	1.05	.0000	.0180	.0144	.0036	0.94	.0010	.0000	.35	0.2
31880	June 27	V. slight.	Slight.	.33	3.95	1.15	.0004	.0218	.0182	.0036	1.02	.0020	.0000	.50	0.3
32105	July 20	Slight.	Slight.	.28	4.00	1.35	.0006	.0250	.0194	.0056	1.05	.0010	.0001	.51	0.3
32720	Aug. 29	Decided.	Cons.	.36	4.50	1.50	.0004	.0276	.0228	.0048	1.10	.0010	.0000	.54	0.2
33517	Oct. 30	Slight.	Slight.	.48	4.50	1.65	.0012	.0356	.0246	.0110	1.13	.0010	.0000	.57	0.3
34250	Dec. 27	Decided.	Cons.	.34	3.85	1.45	.0020	.0384	.0222	.0162	1.19	.0070	.0000	.55	0.3

Averages by Years.

–	1892	–	–	.44	4.03	1.35	.0027	.0181	.0143	.0038	0.91	.0106	.0001	–	0.7
–	1894	–	–	.77	4.79	1.65	.0017	.0319	.0225	.0094	1.16	.0014	.0000	.51	0.6
–	1895	–	–	.60	5.54	2.46	.0010	.0376	.0229	.0147	1.18	.0072	.0001	.70	0.8
–	1896	–	–	.48	4.65	1.77	.0012	.0257	.0197	.0060	1.10	.0017	.0000	.55	0.4
–	1897	–	–	.77	4.75	1.87	.0011	.0282	.0218	.0064	1.18	.0023	.0000	.60	0.7
–	1898	–	–	.45	4.37	1.72	.0004	.0249	.0188	.0061	1.03	.0025	.0000	.51	0.6
–	1899	–	–	.35	4.15	1.62	.0028	.0265	.0201	.0064	1.13	.0016	.0000	.45	0.3
–	1900	–	–	.34	4.21	1.39	.0021	.0267	.0194	.0073	1.10	.0021	.0000	.50	0.3

Note to analyses of 1900: Odor, generally vegetable or unpleasant, sometimes fishy.

GLOUCESTER.

Microscopical Examination of Water from Wallace Pond, Gloucester.

[Number of organisms per cubic centimeter.]

	1900.						
	Feb.	Apr.	June.	July.	Aug.	Oct.	Dec.
Day of examination,	28	26	28	23	30	31	29
Number of sample,	30325	31083	31880	32105	32720	33517	34250
PLANTS.							
Diatomaceæ,	0	11	580	1,205	99	716	25
Asterionella,	0	8	56	4	0	0	4
Synedra,	0	1	518	1,200	99	716	21
Cyanophyceæ, Anabæna,	0	0	0	0	34	0	0
Algæ,	3	1	0	3	6	0	6
ANIMALS.							
Infusoria,	32	106	14	236	57	46	182
Dinobryon,	14	32	6	0	0	0	3
Peridinium,	7	6	8	236	51	34	76
Uroglena,	3	65	0	0	0	4	98
Vermes,	0	0	0	1	2	3	2
Miscellaneous, Zoöglœa,	5	5	5	15	5	7	5
TOTAL,	40	123	599	1,460	203	772	220

Chemical Examination of Water from Various Sources in Gloucester.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
30018	Jan. 23	-	-	0.37	-	-	.0024	.0208	-	-	-	-	-	-	-
30016	Jan. 23	-	-	1.28	-	-	.0010	.0220	-	-	-	-	-	-	-
32102	July 20	V. slight.	Slight.	1.70	5.35	2.60	.0048	.0380	.0304	.0076	1.03	.0010	.0001	1.28	0.5
30017	Jan. 23	-	-	2.40	-	-	.0002	.0294	-	-	-	-	-	-	-
30019	Jan. 23	-	-	1.36	-	-	.0024	.0350	-	-	-	-	-	-	-
32103	July 20	V. slight.	Slight.	1.65	6.40	3.30	.0072	.0516	.0472	.0044	0.96	.0010	.0001	1.61	0.8
30021	Jan. 23	-	-	1.24	-	-	.0002	.0210	-	-	-	-	-	-	-

Odor of No. 32102, faintly unpleasant, becoming fishy on heating; of No. 32103, very faintly vegetable.——The first sample was collected from Haskell's Pond; the second and third, from Fernwood Lake; the fourth, from a brook in Magnolia Swamp; the fifth and sixth, from Lily Pond; the last, from a brook in Cedar Swamp.

GRAFTON.

Water Supply of Grafton. — Grafton Water Company.

The advice of the State Board of Health to the Grafton Water Company, relative to taking a temporary additional water supply from the Quinsigamond River, may be found on page 17 of this volume. The results of analyses of samples of water from the present source of supply and from the Quinsigamond River are given in the following table: —

Chemical Examination of Water from Various Sources in Grafton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
32879	Sept. 11	None.	None.	.00	9.30	.0000	.0014	1.16	.2000	.0001	.00	3.3	.0020
32878	Sept. 11	Slight.	Slight.	.42	10.00	.0040	.0168	0.83	.0550	.0001	.50	3.8	.1180
32864	Sept. 11	None.	None.	.00	16.00	.0000	.0022	2.49	.4800	.0001	.03	4.4	.0060
32865	Sept. 11	V. slight.	Slight.	.13	3.50	.0014	.0214	0.29	.0010	.0000	.33	1.0	-

Odor of the first and third samples, none; of the second, none, becoming very faintly unpleasant on heating; of the last, vegetable. —— The first sample was collected from the filter-gallery of the Grafton Water Company; the second, from a tubular well used as a supplementary source of supply; the third, from a spring on the premises of J. S. Nelson & Co.; the last, from Quinsigamond River, below the factory of Finlayson, Bousfield & Co.

Water Supply of Great Barrington Fire District, Great Barrington.

Chemical Examination of Water from Green River.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30064	Jan. 30	None.	V. slight.	.00	7.55	1.40	.0002	.0018	.0018	.0000	.10	.0320	.0000	.04	5.7
30934	Apr. 6	V. slight.	None.	.00	6.20	1.05	.0000	.0008	.0008	.0000	.10	.0300	.0000	.07	4.9
32099	July 20	V. slight.	V. slight.	.00	8.40	0.95	.0002	.0044	.0038	.0006	.10	.0110	.0001	.08	6.7
3795	Nov. 24	None.	V. slight.	.01	7.50	1.05	.0018	.0042	.0032	.0010	.11	.0170	.0000	.08	5.3
Av...	....	....	....	.00	7.41	1.11	.0005	.0028	.0024	.0004	.10	.0225	.0000	.07	5.6

Odor, none. —— No. 33795 was collected from the river; the others, from a faucet at the pumping station.

GROTON.

WATER SUPPLY OF GROTON. — GROTON WATER COMPANY.

Chemical Examination of Water from the Well of the Groton Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1900.												
30131	Feb. 6	V. slight.	None.	.00	4.80	.0000	.0012	.17	.0060	.0000	.03	2.0	.0180
30930	Apr. 4	None.	None.	.00	3.80	.0000	.0002	.15	.0040	.0000	.02	1.3	.0020
31495	June 6	None.	None.	.00	4.00	.0000	.0010	.14	.0100	.0000	.02	1.4	.0030
32536	Aug. 17	None.	V. slight.	.00	4.20	.0008	.0032	.16	.0100	.0000	.03	2.2	.0020
33235	Oct. 8	None.	None.	.03	5.50	.0000	.0004	.16	.0030	.0000	.01	2.3	.0180
33943	Dec. 4	V. slight.	None.	.01	4.60	.0004	.0016	.13	.0080	.0000	.01	2.3	.0060

Averages by Years.

-	1898	-	-	.03	3.98	.0003	.0013	.19	.0076	.0000	.02	2.2	.0068
-	1899	-	-	.02	4.69	.0001	.0010	.18	.0071	.0000	.02	2.1	.0048
-	1900	-	-	.01	4.48	.0002	.0013	.15	.0068	.0000	.02	1.9	.0082

NOTE to analyses of 1900: Odor, none.

HAMILTON.

The advice of the State Board of Health to George W. Fitz, relative to a water supply for the towns of Hamilton and Wenham, may be found on page 50 of this volume. The results of analyses of samples of water collected from springs and test wells in the valley of Miles River, and of samples collected from a large well during a pumping test, are given in the following tables: —

HAMILTON.

Chemical Examination of Water from Springs and Test Wells in Hamilton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30933	Apr. 5	None.	Cons., earthy.	.00	6.10 4.20	.0010	.0044	.53	.0320	.0000	.11 .03	1.4	.0060 .0020
31069	Apr. 23	V. slight.	Slight.	.00	4.60	.0000	.0022	.52	.0150	.0000	.05	1.1	.0020
33275	Oct. 11	V. slight.	Cons.	.03	5.70	.0000	.0060	.55	.0370	.0001	.13	1.6	.0060
33274	Oct. 11	None.	V. slight.	.01	5.90	.0006	.0018	.53	.0230	.0000	.00	1.3	.0050
32096	July 20	Slight.	V. slight.	.03	5.00	.0012	.0056	.39	.0010	.0000	.03	1.6	.0300
32093	July 20	Decided.	Slight.	.06	14.40	.0046	.0020	.76	.0140	.0009	.03	5.1	.0480
32094	July 20	Decided.	Cons.	.19	15.30	.0052	.0018	.72	.0010	.0004	.05	4.6	.1850
32095	July 20	Decided.	Slight.	.19	14.10	.0050	.0016	.76	.0010	.0001	.05	5.0	.0850
32050	July 17	Decided.	None.	-*	13.20	.0058	.0010	.81	.0000	.0000	.08	5.1	.0980
32111	July 21	Decided.	Cons.	.06	7.60	.0000	.0010	.54	.0010	.0000	.05	2.3	.0380
32396	Aug. 7	Decided.	Cons.	.04	9.40	.0004	.0006	.50	.0050	.0001	.06	1.3	.1620
32768	Aug. 31	Decided.	Cons.	.00	8.40	.0000	.0004	.49	.0080	.0000	.02	1.1	.1500
32767	Aug. 31	V. slight.	Cons.	.00	5.30	.0000	.0006	.45	.0120	.0000	.03	0.6	.0430
32769	Aug. 31	Decided.	Cons.	.30	7.80	.0000	.0024	.62	.0300	.0000	.04	1.6	.2700

Odor, none.——The first three samples were collected from a spring on land of F. N. Knowlton, in the valley of Miles River, near the Essex Branch of the Boston & Maine Railroad, about 300 feet north of Bridge Street; No. 33274 was collected from a spring, about 250 feet south of the spring previously described and about 50 feet from Bridge Street; No. 32096 was collected from a dug well on land of Geo. W. Fitz, near the edge of the meadow bordering Miles River; the remaining samples were collected from the tubular test wells in various parts of the meadow on the southerly side of Miles River, in the vicinity of the point where Bridge Street crosses the Essex Branch of the Boston & Maine Railroad.

* Turbid.

Chemical Examination of Water from Test Wells in Hamilton, collected during a Pumping Test.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
33366	Oct. 19	V. slight.	None.	.02	6.10	.0004	.0012	.50	.0050	.0000	.03	1.8	.0070
33981	Dec. 6	V. slight.	V. slight.	.01	5.50	.0026	.0038	.50	.0060	.0000	.02	1.7	.0050
33982	Dec. 9	V. slight.	V. slight.	.00	5.30	.0006	.0012	.48	.0080	.0000	.06	1.7	.0050
34069	Dec. 10	None.	None.	.00	5.00	.0006	.0016	.51	.0100	.0000	.01	1.8	.0050
34070	Dec. 12	None.	None.	.00	4.40	.0002	.0008	.50	.0080	.0000	.01	1.7	.0050
34084	Dec. 14	None.	V. slight.	.01	5.60	.0008	.0020	.52	.0110	.0000	.01	2.0	.0070
34085	Dec. 13	V. slight.	Slight.	.02	5.90	.0006	.0020	.52	.0090	.0000	.02	2.0	.0180
34095	Dec. 15	V. slight.	None.	.01	5.20	.0002	.0014	.50	.0140	.0000	.02	2.2	.0070
34100	Dec. 16	None.	None.	.00	4.30	.0004	.0006	.48	.0130	.0000	.02	1.6	.0050
34101	Dec. 17	None.	None.	.00	4.50	.0002	.0032	.48	.0130	.0000	.01	1.3	.0050
34145	Dec. 18	None.	None.	.00	5.00	.0006	.0016	.48	.0100	.0000	.01	1.3	.0080
34146	Dec. 18	Slight.	Cons.	-*	9.20	.0008	.0016	.48	.0100	.0001	.02	1.4	.0100
34083	Dec. 14	None.	None.	.00	6.00	.0004	.0012	.51	.0060	.0000	.01	2.1	.0090
34147	Dec. 18	None.	None.	.00	5.20	.0006	.0014	.51	.0070	.0000	.01	2.1	.0080

Odor, none.——The pumping test began December 8 and continued until December 18. The first two samples were collected from a dug well previous to the beginning of the pumping test; the next ten samples were collected from the dug well during the time that water was being pumped from it; the last two samples were collected from a tubular well driven in the center of the dug well, from which water was pumped. During the pumping test water was prevented from flowing from this tubular well into the dug well.

* Turbid.

Hardwick.

The advice of the State Board of Health to the Geo. H. Gilbert Manufacturing Company, relative to the best method of protecting a proposed source of water supply for the village of Gilbertville from pollution, may be found on page 18 of this volume.

Chemical Examination of Water from a Tap in Gilbertville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
31295	1900. May 17	None.	None.	.00	2.70	.0004	.0008	.10	.0050	.0000	.05	0.6	.0030

Odor, none. —— The sample was collected from a tap supplied from a spring which is used for the supply of a considerable number of families in Gilbertville.

Water Supply of Hatfield.

Chemical Examination of Water from the Reservoir of the Hatfield Water Works

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
30301	1900. Feb. 24	V. slight.	V. slight.	.14	3.40	0.90	.0010	.0056	.0052	.0004	.10	.0010	.0000	.22	1.3
31396	May 28	None.	V. slight.	.05	3.25	0.75	.0010	.0054	.0052	.0002	.14	.0080	.0000	.16	1.4
32710	Aug. 28	V. slight.	V. slight.	.02	4.25	1.05	.0010	.0048	.0034	.0014	.10	.0050	.0000	.11	2.0
33857	Nov. 29	V. slight.	V. slight.	.36	4.05	1.50	.0006	.0106	.0102	.0004	.14	.0020	.0001	.59	2.1
Av....	....	....	....	.14	3.74	1.05	.0009	.0066	.0060	.0006	.12	.0040	.0000	.27	1.7

Odor, faintly vegetable or none.

Water Supply of Haverhill.

The advice of the State Board of Health to the city of Haverhill, relative to the protection of the water-shed of Kenoza Lake, one of the sources of water supply of that city, may be found on pages 19 to 21 of this volume.

HAVERHILL.

The advice of the Board, relative to the location of a new pumping station at Kenoza Lake, may be found on page 21 of this volume.

Chemical Examination of Water from Crystal Lake, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
30065	Jan. 30	V. slight.	V. slight.	.10	2.70	1.15	.0024	.0154	.0130	.0024	.23	.0010	.0001	.27	0.8
31092	Apr. 25	V. slight.	Slight.	.15	2.85	0.95	.0010	.0156	.0148	.0008	.19	.0010	.0000	.35	0.8
32329	July 30	V. slight.	Cons.	.10	2.65	1.00	.0002	.0204	.0156	.0048	.23	.0000	.0000	.45	0.6
33493	Oct. 29	V. slight.	V. slight.	.10	3.00	1.40	.0010	.0164	.0158	.0006	.24	.0010	.0000	.29	0.6
Av...	....	....	....	.11	2.80	1.12	.0011	.0169	.0148	.0021	.22	.0008	.0000	.34	0.7

Odor, none. A faintly vegetable or unpleasant odor was developed in three of the samples on heating. —— No. 32329 was collected from a faucet in the city; the others, from the lake, at its outlet.

Chemical Examination of Water from Kenoza Lake, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
30067	Jan. 30	Slight.	V. slight.	.11	3.60	1.40	.0010	.0164	.0148	.0016	.48	.0010	.0001	.23	1.7
31094	Apr. 25	V. slight.	V. slight.	.07	3.50	0.85	.0002	.0140	.0128	.0012	.39	.0010	.0000	.21	1.4
32331	July 30	V. slight.	V. slight.	.04	3.40	1.00	.0000	.0176	.0162	.0014	.37	.0010	.0000	.36	1.6
33495	Oct. 29	V. slight.	V. slight.	.07	3.75	0.90	.0038	.0166	.0152	.0014	.39	.0010	.0000	.23	1.4
Av...	....	....	....	.07	3.56	1.04	.0012	.0161	.0147	.0014	.41	.0010	.0000	.26	1.5

Odor of the first two samples, none; of the last two, vegetable. —— No. 31094 was collected from a faucet in the city; the others, from the lake.

HAVERHILL.

Chemical Examination of Water from Lake Saltonstall, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30030	Jan. 23	None.	V. slight.	.03	5.85	1.45	.0006	.0178	.0168	.0010	.76	.0020	.0000	.19	2.6
30070	Jan. 30	Decided.	Slight.	.25	4.20	1.45	.0024	.0162	.0130	.0032	.39	.0020	.0002	.33	1.6
31097	Apr. 25	Slight.	Cons.	.04	6.15	1.65	.0008	.0188	.0164	.0024	.66	.0020	.0001	.25	2.6
32334	July 30	V. slight.	Slight.	.03	6.10	1.15	.0014	.0208	.0176	.0032	.69	.0000	.0000	.24	2.7
33498	Oct. 29	None.	V. slight.	.05	5.90	1.00	.0012	.0176	.0170	.0006	.72	.0020	.0000	.26	2.7
Av.*.	....	....	....	.06	5.79	1.31	.0012	.0185	.0165	.0020	.66	.0015	.0000	.25	2.5

Odor of No. 32334, faintly unpleasant, becoming stronger on heating; of the others, faintly vegetable or none. A fishy odor was developed in the first sample on heating. This source is not used at the present time for the supply of the city.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Chemical Examination of Water from Lake Pentucket, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30029	Jan. 23	None.	V. slight.	.04	3.60	1.25	.0010	.0166	.0162	.0004	.45	.0030	.0001	.21	2.0
30069	Jan. 30	Slight.	V. slight.	.07	3.90	1.35	.0006	.0156	.0140	.0016	.42	.0020	.0000	.23	1.3
31096	Apr. 25	Slight.	Cons.	.05	3.65	1.40	.0020	.0208	.0194	.0014	.35	.0010	.0000	.21	1.3
32333	July 30	V. slight.	Cons.	.03	3.55	0.85	.0000	.0244	.0180	.0064	.40	.0000	.0000	.26	1.6
33497	Oct. 29	None.	V. slight.	.05	3.50	0.90	.0010	.0184	.0162	.0022	.40	.0000	.0000	.22	1.7
Av.*.	....	....	....	.04	3 61	1.11	.0009	.0199	.0172	.0027	.39	.0009	.0000	.23	1.5

Odor of the last sample, faintly unpleasant, becoming distinctly vegetable on heating; of the others, faintly vegetable or none.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

HAVERHILL.

Chemical Examination of Water from Johnson's Pond in Boxford and Groveland.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30066	Jan. 30	V. slight.	V. slight.	.08	4.10	1.55	.0006	.0158	.0152	.0006	.35	.0010	.0004	.28	1.8
31093	Apr. 25	V. slight.	Cons.	.10	3.65	1.05	.0010	.0164	.0152	.0012	.32	.0010	.0000	.31	1.4
32330	July 30	Slight.	Cons.	.08	3.85	0.95	.0002	.0266	.0176	.0090	.33	.0000	.0000	.42	2.0
33494	Oct. 29	None.	V. slight.	.11	4.25	1.10	.0000	.0182	.0170	.0012	.35	.0010	.0000	.28	2.1
Av...	....	....	....	.09	3.96	1.16	.0004	.0192	.0162	.0030	.34	.0007	.0001	.32	1.8

Odor of the first and third samples, none; of the second, faintly unpleasant; of the last, vegetable. — The first two samples were collected from the pond; the last two, from faucets in the city.

Chemical Examination of Water from Millvale Reservoir on East Meadow River, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30068	Jan. 30	Decided.	Cons.	.42	3.80	1.60	.0012	.0242	.0170	.0072	.30	.0030	.0002	.60	1.3
31095	Apr. 25	Slight.	Cons.	.50	4.15	1.80	.0012	.0204	.0184	.0020	.25	.0010	.0000	.66	1.3
32332	July 30	Slight.	Slight.	.30	4.15	1.00	.0004	.0196	.0184	.0012	.29	.0010	.0000	.58	1.6
33496	Oct. 29	Decided.	Slight.	.38	5.05	1.50	.0012	.0252	.0218	.0034	.35	.0010	.0000	.62	1.7

Averages by Years.

-	1896	-	-	.74	5.15	2.09	.0010	.0223	.0204	.0019	.32	.0044	.0000	.76	1.8
-	1897	-	-	.84	4.99	2.23	.0009	.0236	.0211	.0025	.31	.0040	.0000	.80	1.8
-	1898	-	-	.74	4.78	2.22	.0008	.0221	.0201	.0020	.30	.0030	.0001	.77	1.6
-	1899	-	-	.40	4.42	1.68	.0008	.0184	.0165	.0019	.27	.0024	.0000	.54	1.5
-	1900	-	-	.40	4.29	1.47	.0010	.0223	.0189	.0034	.30	.0015	.0000	.61	1.5

NOTE to analyses of 1900: Odor of the last sample, faintly unpleasant, becoming distinctly disagreeable on heating; of the others, faintly vegetable or none. A fishy odor was developed in the first sample on heating.

HAVERHILL.

The advice of the State Board of Health to the superintendent of parks of Haverhill, relative to the quality of the water of a spring and well in Winnekeni Park, used by the public for drinking purposes, may be found on page 21 of this volume. The results of analyses of samples of water from these sources are given in the following table: —

Chemical Examination of Water from a Spring and Well in Winnekeni Park, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
31220	May 10	None.	V. slight.	.02	2.80	.0002	.0018	.33	.0110	.0000	.06	1.1	.0030
31233	May 11	V. slight.	V. slight.	.00	11.60	.0002	.0054	.80	.1680	.0001	.05	4.3	.0200
31382	May 25	V. slight.	V. slight.	.01	11.10	.0014	.0040	.81	.1840	.0000	.04	4.2	.0250

Odor, none. —— The first sample was collected from a spring, near Kenoza Lake; the last two, from a well, near Winnekeni Castle.

Water Supply of Hingham and Hull. — Hingham Water Company.

Chemical Examination of Water from Accord Pond, Hingham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
29855	Jan. 3	V. slight.	V. slight.	.15	3.10	1.15	.0002	.0136	.0128	.0008	.68	.0020	.0001	.35	0.3
30136	Feb. 7	V. slight.	V. slight.	.15	2.70	1.55	.0006	.0130	.0130	.0000	.64	.0020	.0001	.33	0.3
30406	Mar. 7	V. slight.	V. slight.	.20	2.70	1.20	.0002	.0132	.0122	.0010	.66	.0010	.0000	.36	0.0
30927	Apr. 4	V. slight.	V. slight.	.17	2.75	1.05	.0000	.0118	.0116	.0002	.63	.0010	.0000	.37	0.0
31152	May 2	V. slight.	V. slight.	.18	2.85	1.15	.0002	.0116	.0106	.0010	.61	.0010	.0001	.35	0.3
31484	June 6	V. slight.	V. slight.	.23	3.05	1.20	.0012	.0150	.0148	.0002	.60	.0020	.0001	.37	0.3
31941	July 2	V. slight.	V. slight.	.19	2.80	1.00	.0010	.0180	.0148	.0032	.56	.0010	.0000	.38	0.2
32401	Aug. 7	V. slight.	V. slight.	.11	2.80	0.85	.0000	.0150	.0134	.0016	.60	.0000	.0000	.33	0.0
32837	Sept. 5	V. slight.	V. slight.	.08	2.55	0.90	.0002	.0140	.0124	.0016	.66	.0020	.0000	.29	0.0
33181	Oct. 3	None.	V. slight.	.10	2.75	1.10	.0016	.0134	.0126	.0008	.64	.0010	.0000	.28	0.0
33608	Nov. 7	None.	V. slight.	.10	2.80	0.75	.0008	.0132	.0124	.0008	.64	.0020	.0000	.27	0.0
33955	Dec. 5	None.	Slight.	.30	2.80	1.10	.0012	.0162	.0122	.0040	.63	.0050	.0000	.42	0.3

HINGHAM AND HULL.

Chemical Examination of Water from Accord Pond, Hingham — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
-	1888	-	-	.22	2.93	0.97	.0001	.0162	-	-	.56	.0046	.0001	-	-
-	1893	-	-	.16	3.02	1.00	.0003	.0121	.0103	.0018	.63	.0032	.0000	.29	0.3
-	1894	-	-	.20	3.04	1.11	.0002	.0114	.0097	.0017	.62	.0024	.0000	.33	0.3
-	1895	-	-	.22	3.50	1.37	.0008	.0135	.0121	.0014	.67	.0110	.0000	.31	0.3
-	1896	-	-	.22	3.02	1.22	.0007	.0150	.0132	.0018	.62	.0027	.0000	.37	0.3
-	1897	-	-	.28	3.01	0.95	.0005	.0145	.0117	.0028	.69	.0037	.0000	.35	0.5
-	1898	-	-	.31	3.19	1.40	.0009	.0175	.0139	.0036	.63	.0008	.0000	.42	0.5
-	1899	-	-	.20	3.05	1.35	.0006	.0151	.0133	.0018	.62	.0016	.0000	.40	0.2
-	1900	-	-	.16	2.80	1.08	.0006	.0140	.0127	.0013	.63	.0017	.0000	.34	0.1

NOTE to analyses of 1900: Odor, faintly vegetable or none, occasionally becoming stronger, and in the third sample oily, on heating.

Microscopical Examination of Water from Accord Pond, Hingham.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	4	8	8	5	3	7	5	8	7	4	8	7
Number of sample,	29855	30136	30406	30927	31152	31484	31941	32401	32837	33181	33608	33955
PLANTS.												
Diatomaceæ,	20	50	56	106	156	11	32	0	18	2	27	105
Asterionella,	8	8	10	0	100	0	9	0	0	0	16	12
Melosira,	0	0	0	51	12	0	0	0	18	0	0	0
Synedra,	3	3	3	10	1	1	22	0	0	1	1	80
Cyanophyceæ, Merismopœdia,	0	0	0	0	0	0	0	20	0	0	0	0
Algæ,	0	0	8	13	0	63	0	0	31	18	0	1
Protococcus,	0	0	0	13	0	63	0	0	31	18	0	0
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	1	0	0	1	0	0	0	0	0
Infusoria,	26	3	7	5	1	0	24	17	2	11	1	3
Dinobryon,	18	1	5	2	1	0	13	0	0	5	0	3
Peridinium,	2	1	1	0	0	0	3	12	2	0	0	0
Vermes,	0	0	0	1	0	0	1	0	2	0	0	0
Crustacea, Cyclops,	0	0	0	0	0	0	0	0	0	pr.	0	0
Miscellaneous, Zoöglœa,	3	3	3	3	3	3	3	3	3	3	5	5
TOTAL,	49	56	74	129	160	77	61	40	56	34	33	114

HINGHAM AND HULL.

Chemical Examination of Water from Fulling Mill Pond, Hingham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30137	Feb. 7	V. slight.	Slight.	.07	4.80	1.70	.0002	.0076	.0052	.0024	.76	.0090	.0001	.13	1.3
31153	May 2	V. slight.	Slight.	.08	4.30	1.15	.0002	.0066	.0050	.0016	.74	.0040	.0001	.16	1.1
32402	Aug. 7	V. slight.	V. slight.	.15	5.15	0.80	.0066	.0096	.0088	.0008	.82	.0110	.0002	.19	1.4
33609	Nov. 7	None.	V. slight.	.07	5.10	0.90	.0018	.0054	.0038	.0016	.81	.0230	.0000	.06	1.3
Av...	....	....	....	.09	4.84	1.14	.0022	.0073	.0057	.0016	.78	.0117	.0001	.13	1.3

Odor of the first and last samples, none; of the others, faintly vegetable —— The samples were collected from the gate-house, and represent water from the filter basin on the shore of Fulling Mill Pond.

Water Supply of Hinsdale Fire District, Hinsdale.

Chemical Examination of Water from the Storage Reservoir of the Hinsdale Fire District.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30377	Mar. 5	V. slight.	Slight.	.09	1.85	0.70	.0006	.0104	.0078	.0026	.05	.0010	.0000	.25	0.2
31077	Apr. 24	V. slight.	Slight.	.10	1.80	0.70	.0018	.0096	.0068	.0028	.07	.0010	.0000	.24	0.0
31874	June 27	Decided.	Cons.	.09	1.80	0.85	.0002	.0262	.0118	.0144	.07	.0010	.0000	.35	0.0
32695	Aug. 28	Decided.	Slight.	.20	2.00	0.90	.0004	.0222	.0170	.0052	.07	.0010	.0000	.38	0.0
33514	Oct. 30	Decided.	Slight.	.48	2.35	1.25	.0012	.0300	.0212	.0088	.07	.0000	.0000	.52	0.0
34231	Dec. 26	V. slight.	V. slight.	.31	2.65	0.70	.0058	.0230	.0162	.0068	.07	.0060	.0000	.57	0.2
Av...	....	....	....	.21	2.07	0.85	.0017	.0202	.0135	.0067	.07	.0017	.0000	.38	0.1

Odor of the first, second and last samples, none; of the others, unpleasant, becoming stronger, and in the third sample also fishy, on heating.

HINSDALE.

Microscopical Examination of Water from the Storage Reservoir of the Hinsdale Fire District.

[Number of organisms per cubic centimeter.]

	1900. Mar.	April.	June.	Aug.	Oct.	Dec.
Day of examination,	7	25	28	29	31	27
Number of sample,	30377	31077	31874	32695	33514	34231
PLANTS.						
Diatomaceæ,	10	1	5	8	27	6
Cyanophyceæ, Microcystis,	0	0	0	2	0	0
Algæ,	1	0	11	0	146	0
Staurastrum,	0	0	0	0	140	0
ANIMALS.						
Rhizopoda, Actinophrys,	0	0	0	0	1	0
Infusoria,	17	23	3,022	137	11	10
Dinobryon,	2	7	1	58	4	0
Peridinium,	15	16	3,020	78	4	10
Vermes, Polyarthra,	0	1	0	0	0	0
Miscellaneous, Zoögiœa,	6	5	3	5	3	3
TOTAL,	34	30	3,041	152	188	19

WATER SUPPLY OF HOLBROOK.

(See *Randolph*.)

WATER SUPPLY OF HOLLISTON. — HOLLISTON WATER COMPANY.

Chemical Examination of Water from the Well of the Holliston Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron
	1900.												
30032	Jan. 23	V. slight.	None.	.21	3.60	.0000	.0118	.28	.0030	.0001	.37	1.0	.0110
30838	Mar. 27	V. slight.	V. slight.	.27	3.20	.0010	.0124	.21	.0020	.0001	.40	0.8	.0190
31339	May 22	Slight.	None.	.30	3.60	.0002	.0124	.26	.0050	.0000	.36	1.1	.0340
32359	Aug. 1	V. slight.	V. slight.	.33	3.60	.0014	.0068	.28	.0050	.0003	.15	1.3	.0660
33008	Sept. 19	None.	V. slight.	.05	4.40	.0000	.0044	.30	.0020	.0000	.05	1.6	.0080
33793	Nov. 22	None.	V. slight.	.09	4.30	.0012	.0062	.35	.0080	.0001	.10	1.6	.0270

HOLLISTON.

Chemical Examination of Water from the Well of the Holliston Water Company — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1892	-	-	.05	4.16	.0001	.0043	.27	.0108	.0000	-	2.1	.0430
-	1894	-	-	.10	4.60	.0001	.0035	.32	.0155	.0001	.08	2.4	.0218
-	1895	-	-	.25	4.28	.0006	.0097	.31	.0117	.0000	.29	1.6	.0095
-	1896	-	-	.28	3.68	.0003	.0114	.28	.0052	.0000	.30	1.0	.0087
-	1897	-	-	.25	3.92	.0008	.0093	.33	.0103	.0000	.22	1.5	.0015
-	1898	-	-	.38	3.82	.0011	.0123	.28	.0045	.0000	.34	1.2	.0243
-	1899	-	-	.21	3.88	.0008	.0077	.26	.0043	.0000	.22	1.1	.0168
-	1900	-	-	.21	3.78	.0006	.0090	.23	.0042	.0001	.24	1.2	.0275

NOTE to analyses of 1900: Odor, none, becoming generally faintly vegetable on heating.—— Nos. 30838 and 31339 were collected from a faucet at the pumping station; the others, from the well.

Water Supply of Holyoke.

Chemical Examination of Water from Whiting Street Storage Reservoir, Holyoke.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30001	Jan. 20	Decided.	Slight.	.12	4.90	1.30	.0062	.0372	.0308	.0064	.11	.0050	.0003	.34	2.6
30312	Feb. 26	None.	V. slight.	.17	5.55	1.90	.0040	.0120	.0090	.0030	.08	.0330	.0002	.24	2.7
30800	Mar. 27	V. slight.	V. slight.	.10	3.70	1.20	.0012	.0138	.0114	.0024	.09	.0020	.0001	.24	1.8
31151	May 2	V. slight.	V. slight.	.08	3.65	1.05	.0006	.0250	.0222	.0028	.12	.0000	.0001	.24	1.7
31342	May 22	Slight.	Cons.	.11	3.60	0.80	.0014	.0194	.0144	.0050	.12	.0050	.0000	.25	2.2
31847	June 25	V. slight.	Slight.	.09	3.50	0.90	.0008	.0226	.0178	.0048	.11	.0010	.0000	.24	2.1
32326	July 31	Slight.	Cons.	.08	4.25	1.00	.0014	.0298	.0194	.0104	.11	.0000	.0000	.30	2.3
32709	Aug. 27	Slight.	Cons.	.05	5.65	1.75	.0048	.0292	.0194	.0098	.10	.0030	.0000	.31	2.3
33075	Sept. 25	Slight.	Cons.	.10	5.30	1.30	.0012	.0376	.0198	.0178	.11	.0010	.0000	.33	2.6
33399	Oct. 23	V. slight.	Slight.	.14	5.70	1.20	.0036	.0352	.0236	.0116	.09	.0010	.0001	.33	2.7
33813	Nov. 27	Decided.	Cons.	.10	4.40	1.25	.0024	.0292	.0208	.0084	.13	.0020	.0000	.35	2.3
34238	Dec. 26	V. slight.	Cons.	.10	4.75	1.50	.0010	.0264	.0186	.0078	.14	.0050	.0002	.37	2.5

Averages by Years.

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
-	1891	-	-	.41	6.34	2.05	.0125	.0311	.0253	.0058	.12	.0185	.0006	-	3.1
-	1892	-	-	.30	5.57	1.86	.0029	.0294	.0247	.0047	.14	.0192	.0001	-	2.8
-	1893	-	-	.18	4.67	1.63	.0008	.0251	.0183	.0068	.13	.0063	.0001	.38	2.5
-	1894	-	-	.27	5.03	1.29	.0007	.0204	.0155	.0049	.16	.0067	.0000	.33	2.9
-	1895	-	-	.23	5.62	1.70	.0056	.0311	.0206	.0105	.16	.0043	.0001	.33	3.1
-	1896	-	-	.23	5.20	1.44	.0061	.0255	.0176	.0079	.15	.0048	.0000	.28	2.8
-	1897	-	-	.17	4.74	1.56	.0005	.0272	.0191	.0081	.12	.0012	.0000	.31	2.7
-	1898	-	-	.13	4.30	1.37	.0045	.0253	.0172	.0081	.10	.0021	.0001	.26	2.3
-	1899	-	-	.17	4.79	1.50	.0080	.0362	.0221	.0141	.09	.0039	.0001	.31	2.4
-	1900	-	-	.10	4.58	1.30	.0024	.0264	.0189	.0075	.11	.0048	.0001	.29	2.3

NOTE to analyses of 1900: Odor of No. 32326, distinctly grassy; of the others, generally faintly vegetable or none.

HOLYOKE.

Microscopical Examination of Water from Whiting Street Storage Reservoir, Holyoke.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	May.	May.	June.	Aug.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	22	27	28	3	23	26	2	30	26	24	28	28
Number of sample,	30001	30312	30800	31151	31342	31847	32326	32709	33075	33399	33813	34238
PLANTS.												
Diatomaceæ,	31	0	68	430	304	1,135	39	39	19	514	830	3,078
Asterionella,	30	0	59	54	222	1,114	0	0	14	350	104	372
Fragilaria,	0	0	3	86	65	16	33	38	0	100	230	66
Synedra,	1	0	6	288	0	1	5	1	4	52	496	2,640
Cyanophyceæ,	0	0	0	0	2	0	194	139	210	2	0	0
Anabæna,	0	0	0	0	0	0	43	9	38	2	0	0
Aphanizomenon,	0	0	0	0	0	0	0	0	142	0	0	0
Clathrocystis,	0	0	0	0	2	0	0	1	20	0	0	0
Cœlosphærium,	0	0	0	0	0	0	151	129	10	0	0	0
Algæ,	0	0	0	4	45	420	11	26	8	5,030	624	24
Protococcus,	0	0	0	0	39	364	0	22	0	5,000	496	20
Raphidium,	0	0	0	0	0	16	0	0	1	22	64	2
Scenedesmus,	0	0	0	0	0	0	0	0	0	2	62	2
ANIMALS.												
Infusoria,	463	0	239	90	24	4	59	10	9	0	8	174
Dinobryon,	460	0	239	88	21	0	0	0	0	0	2	174
Peridinium,	0	0	0	2	2	0	46	8	4	0	0	0
Trachelomonas,	2	0	0	0	0	0	11	2	1	0	6	0
Vermes,	0	0	0	1	3	0	1	0	3	0	4	2
Crustacea,	0	0	0	0	0	0	pr.	pr.	pr.	pr.	pr.	pr.
Cyclops,	0	0	0	0	0	0	pr.	pr.	pr.	pr.	pr.	pr.
Daphnia,	0	0	0	0	0	0	pr.	0	0	0	0	0
Miscellaneous, Zoöglœa,	0	5	5	5	5	5	8	8	10	5	5	3
TOTAL,	494	5	312	530	383	1,564	312	222	259	5,551	1,471	3,281

HOLYOKE.

Chemical Examination of Water from Wright and Ashley Ponds, Holyoke.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30310	Feb. 26	V. slight.	Slight.	.10	4.65	1.40	.0020	.0236	.0218	.0018	.11	.0070	.0000	.28	2.3
31340	May 22	V. slight.	Slight.	.05	3.85	0.80	.0008	.0164	.0126	.0038	.14	.0040	.0000	.21	2.3
32707	Aug. 27	V. slight.	V. slight.	.04	4.20	1.40	.0058	.0238	.0204	.0034	.14	.0020	.0000	.35	2.0
33811	Nov. 27	V. slight.	Slight.	.11	4.15	1.00	.0086	.0156	.0138	.0018	.14	.0060	.0003	.22	2.6
Av...	....	....	....	.07	4.21	1.15	.0043	.0198	.0171	.0027	.13	.0047	.0001	.26	2.3

Odor, vegetable or none.

Chemical Examination of Water from Fomar Reservoir on the Manhan River, Southampton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30311	Feb. 26	Slight.	Slight.	.40	2.70	1.30	.0008	.0232	.0206	.0026	.08	.0010	.0000	.58	0.6
31341	May 22	V. slight.	Slight.	.50	3.60	1.60	.0006	.0148	.0132	.0016	.09	.0030	.0000	.71	1.3
32708	Aug. 27	None.	V. slight.	.10	4.00	1.00	.0006	.0060	.0056	.0004	.10	.0020	.0000	.20	1.6
33812	Nov. 27	Decided.	Cons.	.66	4.60	1.70	.0024	.0276	.0192	.0084	.11	.0060	.0000	.96	1.7

Averages by Years.

-	1898	-	-	.40	3.60	1.40	.0005	.0109	.0096	.0013	.10	.0028	.0000	.46	1.2
-	1899	-	-	.21	3.65	1.26	.0003	.0101	.0081	.0020	.10	.0012	.0001	.32	1.3
-	1900	-	-	.41	3.72	1.40	.0011	.0179	.0147	.0032	.09	.0030	.0000	.61	1.3

NOTE to analyses of 1900: Odor, vegetable or none.

HOLYOKE.

The advice of the State Board of Health to the Deane Steam Pump Company, relative to the quality of the water of certain wells for drinking purposes, may be found on page 22 of this volume. The results of analyses of samples of water collected from the wells are given in the following table: —

Chemical Examination of Water from the Wells of the Deane Steam Pump Company, Holyoke.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
31302	May 18	Slight.	Cons.	.10	4.80	.0004	.0134	.13	.0080	.0000	.23	2.7	.0120
31507	June 9	None.	V. slight.	.01	16.60	.0004	.0012	.82	.0960	.0002	.08	8.9	.0100
31826	June 22	None.	V. slight.	.00	19.00	.0002	.0014	.88	.5000	.0001	.02	8.4	.0060

Odor of the first sample, none, becoming distinctly vegetable on heating; of the second, faintly earthy; of the last, none.

Water Supply of Hopedale.

(See *Milford.*)

Water Supply of Hopkinton.

Chemical Examination of Water from the Tubular Wells of the Hopkinton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29873	Jan. 8	None.	None.	.00	11.20	.0000	.0006	1.35	.0390	.0004	.02	4.3	.0040
30424	Mar. 7	None.	None.	.00	10.70	.0000	.0018	1.14	.4000	.0000	.04	4.2	.0080
31558	June 12	None.	None.	.00	11.40	.0004	.0028	1.06	.3300	.0000	.01	4.4	.0030
32849	Sept. 8	None.	V. slight.	.01	13.20	.0000	.0004	1.36	.3900	.0000	.01	4.9	.0280
34167	Dec. 19	None.	V. slight.	.00	8.80	.0006	.0020	1.36	.4900	.0000	.02	5.0	.0480
Av...	....	....	....	.00	11.06	.0002	.0015	1.25	.3298	.0001	.02	4.6	.0182

Odor, none.

Water Supply of Hudson.

Chemical Examination of Water from Gates Pond, Berlin.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
29981	Jan. 18	None.	None.	.02	2.75	1.20	.0050	.0166	.0162	.0004	.27	.0020	.0001	.20	0.6
30685	Mar. 21	V. slight.	Slight.	.08	2.05	0.90	.0002	.0156	.0140	.0016	.23	.0020	.0000	.20	0.6
31265	May 15	None.	V. slight.	.01	2.05	0.75	.0014	.0126	.0114	.0012	.20	.0010	.0000	.19	0.5
32337	Aug. 1	V. slight.	V. slight.	.03	2.50	1.00	.0000	.0162	.0160	.0002	.18	.0000	.0000	.27	0.3
33086	Sept. 26	V. slight.	Slight.	.06	2.40	0.85	.0000	.0156	.0140	.0016	.19	.0010	.0000	.19	0.3
33807	Nov. 27	V. slight.	V. slight.	.11	2.50	1.00	.0066	.0162	.0148	.0014	.25	.0040	.0000	.25	0.6

Averages by Years.

-	1888	-	-	.06	2.55	0.69	.0015	.0158	-	-	.19	.0055	.0001	-	-
-	1889	-	-	.03	2.14	0.58	.0020	.0189	.0139	.0050	.19	.0048	.0001	-	-
-	1890	-	-	.02	2.82	1.04	.0023	.0161	.0124	.0037	.21	.0054	.0000	-	1.2
-	1891	-	-	.04	2.52	0.90	.0011	.0150	.0117	.0033	.20	.0074	.0000	-	0.9
-	1893	-	-	.05	2.45	1.01	.0040	.0178	.0146	.0032	.23	.0039	.0000	.20	0.6
-	1894	-	-	.04	2.27	0.83	.0016	.0148	.0124	.0024	.22	.0008	.0000	.15	0.6
-	1895	-	-	.05	2.45	0.92	.0015	.0175	.0144	.0031	.23	.0027	.0000	.20	0.9
-	1896	-	-	.06	2.43	0.84	.0037	.0150	.0123	.0027	.26	.0050	.0000	.17	0.9
-	1897	-	-	.05	2.20	0.92	.0047	.0159	.0139	.0020	.23	.0028	.0000	.15	0.6
-	1898	-	-	.07	2.37	0.99	.0019	.0155	.0133	.0022	.24	.0026	.0000	.18	0.7
-	1899	-	-	.05	2.55	1.11	.0021	.0149	.0135	.0014	.19	.0009	.0000	.19	0.5
-	1900	-	-	.05	2.37	0.95	.0022	.0155	.0144	.0011	.22	.0017	.0000	.22	0.5

Note to analyses of 1900: Odor of the second sample, faintly unpleasant, becoming also oily on heating; of the others, none, generally becoming vegetable or unpleasant on heating.

Microscopical Examination.

The organism *Uroglena* was found in considerable numbers in the sample collected in March. An insignificant number of organisms was found in the other samples.

HUDSON.

Chemical Examination of Water from Fosgate Brook, Berlin.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29980	Jan. 18	None.	V. slight.	.26	4.40	1.65	.0008	.0116	.0114	.0002	.19	.0320	.0001	.47	1.4
30237	Feb. 20	V. slight.	V. slight.	.28	3.30	1.30	.0004	.0100	.0098	.0002	.19	.0150	.0000	.42	0.5
30684	Mar. 21	None.	V. slight.	.25	2.65	1.00	.0000	.0080	.0074	.0006	.19	.0140	.0000	.30	0.6
30998	Apr. 12	V. slight.	V. slight.	.30	3.20	1.20	.0000	.0114	.0112	.0002	.18	.0070	.0000	.45	0.6
31264	May 15	V. slight.	V. slight.	.34	3.25	1.05	.0002	.0132	.0110	.0022	.17	.0120	.0000	.47	0.8
31772	June 19	Slight.	Cons.	.36	4.35	1.25	.0024	.0176	.0160	.0016	.16	.0080	.0001	.43	1.3
33806	Nov. 27	V. slight.	V. slight.	.62	5.95	2.55	.0036	.0272	.0232	.0040	.26	.0140	.0000	.62	1.8
34124	Dec. 18	V slight.	V. slight.	.51	5.15	2.05	.0012	.0170	.0162	.0008	.23	.0410	.0000	.78	1.3
Av...	....	....	....	.36	4.03	1.51	.0011	.0145	.0133	.0012	.20	.0179	.0000	.49	1.0

Odor of the second and last samples, faintly vegetable, becoming stronger on heating; of the others, none, generally becoming vegetable on heating. Water from Fosgate Brook is diverted into Gates Pond.

Water Supply of Hull.

(See *Hingham.*)

Water Supply of Huntington Fire District.

Chemical Examination of Water from Cold Brook Reservoir, Huntington.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30437	Mar. 11	V. slight.	V. slight.	.08	2.20	0.80	.0002	.0036	.0032	.0004	.09	.0030	.0001	.17	0.3
31076	Apr. 24	V. slight.	V. slight.	.16	2.30	0.90	.0006	.0176	.0174	.0002	.12	.0010	.0000	.31	0.2
31825	June 22	V. slight.	Slight.	.11	3.60	1.10	.0010	.0148	.0122	.0026	.11	.0010	.0000	.22	1.0
32846	Sept. 6	V. slight.	Slight.	.06	3.85	0.75	.0000	.0036	.0032	.0004	.09	.0000	.0000	.11	1.8
33533	Nov. 1	V. slight.	V. slight.	.10	4.50	1.05	.0004	.0126	.0122	.0004	.21	.0020	.0000	.28	1.3
34212	Dec. 25	None.	V. slight.	.25	3.20	1.20	.0008	.0114	.0102	.0012	.12	.0140	.0000	.43	0.8
Av...	....	....	....	.13	3.27	0.97	.0005	.0106	.0097	.0009	.12	.0035	.0000	.25	0.9

Odor of the third and fifth samples, vegetable; of the others, none. —— Nos. 30437 and 34212 were collected from a faucet; the others, from the reservoir.

Water Supply of Hyde Park and Milton. — Hyde Park Water Company.

The advice of the State Board of Health to the Hyde Park Water Company, relative to the quality of the water furnished by the new wells of the Hyde Park Water Company, located near Mother Brook, may be found on page 22 of this volume. The results of chemical analyses of samples collected from the new wells during a pumping test are given in one of the following tables: —

Chemical Examination of Water from the Wells of the Hyde Park Water Company near the Neponset River.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29954	Jan. 16	V. slight.	V. slight.	.04	12.00	.0132	.0034	1.64	.1120	.0003	.11	4.6	.0650
30239	Feb. 20	V. slight.	V. slight.	.02	10.00	.0082	.0036	1.26	.1120	.0002	.10	4.0	.0330
30638	Mar. 20	V. slight.	V. slight.	.06	8.00	.0054	.0030	0.97	.0860	.0003	.07	3.4	.0390
31022	Apr. 17	V. slight.	Slight.	.03	10.40	.0092	.0040	1.10	.1280	.0001	.07	4.0	.0290
31259	May 15	V. slight.	V. slight.	.02	9.40	.0066	.0022	1.06	.1260	.0001	.06	3.8	.0200
31782	June 19	None.	V. slight.	.01	12.00	.0148	.0032	1.21	.0640	.0002	.10	5.0	.0120
32312	July 31	None.	V. slight.	.02	13.20	.0206	.0038	1.55	.1480	.0003	.09	5.3	.0060
32706	Aug. 29	V. slight.	V. slight.	.02	13.80	.0228	.0050	1.78	.1100	.0003	.12	5.1	.0130
33045	Sept. 24	V. slight.	V. slight.	.04	13.70	.0212	.0056	2.03	.1200	.0001	.12	5.4	.0200
33500	Oct. 30	V. slight.	None.	.08	8.20	.0208	.0062	2.11	.0760	.0000	.16	4.4	.0360
33823	Nov. 27	V. slight.	V. slight.	.14	13.20	.0236	.0052	2.09	.0840	.0001	.11	4.9	.0550
34216	Dec. 24	V. slight.	Slight.	.09	8.60	.0168	.0062	1.72	.1360	.0001	.11	5.0	.0800

Averages by Years.

-	1888	-	-	.00	6.06	.0001	.0023	0.75	.0641	.0002	-	-	-
-	1893	-	-	.02	8.62	.0031	.0032	1.19	.0879	.0002	.10	3.7	.0112
-	1894	-	-	.03	9.68	.0040	.0039	1.37	.0843	.0001	.09	3.9	.0175
-	1895	-	-	.04	9.44	.0063	.0035	1.31	.0867	.0001	.09	4.0	.0149
-	1896	-	-	.03	9.68	.0084	.0046	1.21	.0882	.0003	.11	4.1	.0141
-	1897	-	-	.04	9.94	.0093	.0037	1.30	.1170	.0002	.08	4.2	.0089
-	1898	-	-	.08	10.28	.0120	.0046	1.17	.1271	.0003	.12	4.4	.0113
-	1899	-	-	.04	10.39	.0122	.0041	1.24	.1043	.0002	.10	4.2	.0107
-	1900	-	-	.05	11.04	.0153	.0043	1.54	.1085	.0002	.10	4.6	.0340

Note to analyses of 1900: Odor of No. 33045, faintly unpleasant; of the others, none. A faintly unpleasant odor was developed in No. 33823 on heating. —— The samples were collected from a faucet at the pumping station. For the results of examinations of water from the Neponset River opposite the wells of the Hyde Park Water Company, see "Neponset River," in the chapter on the Examination of Rivers.

HYDE PARK AND MILTON.

Chemical Examination of Water from a System of Tubular Wells located in the Valley of Mother Brook near the Boundary Line between Dedham and Hyde Park.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1899.												
29682	Dec. 18	None.	None.	.01	10.20	.0000	.0010	1.12	.3800	.0006	.03	3.3	.0040
29683	Dec. 18	None.	None.	.03	10.00	.0000	.0012	1.12	.3640	.0004	.02	3.3	.0030
29696	Dec. 18	None.	None.	.00	9.40	.0000	.0012	1.12	.3600	.0001	.02	3.6	.0030
29697	Dec. 19	None.	None.	.00	9.10	.0000	.0012	1.10	.2700	.0000	.02	3.6	.0040
29717	Dec. 19	None.	None.	.00	8.90	.0002	.0016	1.12	.2400	.0000	.01	3.0	.0020
29718	Dec. 20	None.	None.	.04	9.10	.0000	.0010	1.12	.2800	.0000	.02	3.0	.0040
29735	Dec. 20	None.	None.	.00	9.00	.0002	.0014	1.10	.2850	.0000	.01	3.0	.0080
29741	Dec. 21	None.	None.	.00	8.90	.0000	.0010	1.09	.2650	.0000	.02	3.0	.0030
29749	Dec. 22	None.	None.	.00	8.60	.0000	.0000	1.07	.2650	.0000	.02	2.6	.0040
29773	Dec. 26	None.	None.	.05	8.70	.0010	.0028	1.04	.2900	.0000	.02	2.6	.0050
29810	Dec. 28	None.	None.	.00	8.80	.0000	.0010	1.03	.2300	.0001	.02	2.9	.0020
Av...	....	....	....	.01	9.15	.0001	.0012	1.09	.2935	.0001	.02	3.1	.0038

Odor, none.

Water Supply of Ipswich.

Chemical Examination of Water from the Storage Reservoir of the Ipswich Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30071	Jan. 30	Slight.	V. slight.	.20	3.80	1.20	.0010	.0182	.0152	.0030	.43	.0060	.0001	.34	1.0
30717	Mar. 23	Slight.	Cons.	.26	3.95	1.45	.0004	.0170	.0146	.0024	.40	.0050	.0000	.39	0.8
31356	May 22	V. slight.	Slight.	.55	4.60	1.50	.0012	.0208	.0176	.0032	.51	.0080	.0000	.67	1.1
32284	July 29	Slight.	V. slight.	.12	5.00	1.25	.0012	.0232	.0198	.0034	.52	.0000	.0000	.35	1.4
32934	Sept. 14	Slight.	Slight.	.16	4.40	1.00	.0014	.0276	.0262	.0014	.54	.0020	.0000	.43	1.7
33796	Nov. 25	V. slight.	V. slight.	.21	5.05	1.50	.0052	.0292	.0250	.0042	.60	.0050	.0000	.50	2.1
34104	Dec. 17	V. slight.	V. slight.	.55	5.95	1.50	.0064	.0252	.0246	.0006	.77	.0160	.0004	.61	2.7

IPSWICH.

Chemical Examination of Water from the Storage Reservoir of the Ipswich Water Works — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
–	1895	–	–	.45	5.25	1.89	.0022	.0194	.0169	.0025	.76	.0072	.0001	.50	1.9
–	1896	–	–	.32	4.60	1.54	.0017	.0178	.0147	.0031	.67	.0058	.0001	.41	1.7
–	1897	–	–	.33	4.64	1.64	.0023	.0196	.0169	.0027	.62	.0058	.0000	.39	1.6
–	1898	–	–	.46	4.74	1.79	.0020	.0191	.0160	.0031	.55	.0048	.0001	.49	1.5
–	1899	–	–	.17	4.23	1.44	.0011	.0204	.0180	.0024	.48	.0034	.0000	.36	1.4
–	1900	–	–	.29	4.68	1.34	.0024	.0230	.0204	.0026	.54	.0060	.0001	.47	1.5

NOTE to analyses of 1900: Odor, faintly vegetable or none, sometimes becoming unpleasant, and occasionally fishy, on heating.

Microscopical Examination of Water from the Storage Reservoir of the Ipswich Water Works.

[Number of organisms per cubic centimeter.]

	1900. Jan.	Mar.	May.	July.	Sept.	Nov.	Dec.
Day of examination,	31	26	23	30	15	26	18
Number of sample,	30071	30717	31356	32284	32934	33796	34104
PLANTS.							
Diatomaceæ,	0	27	100	4	8	2	11
Synedra,	0	8	99	4	0	2	0
Cyanophyceæ,	0	0	0	0	22	0	0
Chroöcoccus,	0	0	0	0	20	0	0
ANIMALS.							
Rhizopoda, Actinophrys,	0	0	0	1	0	0	0
Infusoria,	21	39	237	0	23	27	0
Dinobryon,	3	26	221	0	0	0	0
Peridinium,	16	12	0	0	10	0	0
Synura,	1	0	15	0	0	0	0
Uroglena,	0	0	0	0	0	27	0
Crustacea, Cyclops,	0	0	0	0	0	pr.	0
Miscellaneous, Zoöglœa,	3	3	5	5	5	8	3
TOTAL,	24	69	342	10	58	37	14

KINGSTON.

Water Supply of Kingston.

Chemical Examination of Water from the Wells of the Kingston Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
33363	Oct. 17	None.	None.	.00	5.30	.0010	.0022	.90	.0770	.0000	.01	1.1	.0180

Odor, none. —— The sample was collected from a faucet at the pumping station.

Water Supply of Lancaster.

(See *Clinton.*)

Water Supply of Lawrence.

Chemical Examination of Water from the Merrimack River above Lawrence, opposite the Intake of the Lawrence Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
29972	Jan. 17	Slight.	Slight.	.22	4.85	1.60	.0138	.0250	.0206	.0044	.34	.0060	.0004	.46	1.3
30258	Feb. 21	Slight.	Slight.	.40	3.35	1.65	.0038	.0204	.0170	.0034	.13	.0080	.0002	.69	0.6
30677	Mar. 21	Decided.	Cons.	.34	3.10	1.40	.0026	.0158	.0130	.0028	.14	.0040	.0000	.50	0.5
31033	Apr. 18	Decided.	Cons.	.28	3.50	1.15	.0006	.0160	.0150	.0010	.11	.0060	.0000	.49	0.6
31272	May 16	Slight.	Slight.	.31	3.00	1.10	.0026	.0192	.0162	.0030	.16	.0020	.0000	.48	0.8
31794	June 20	Decided.	Cons.	.29	3.95	1.55	.0102	.0226	.0180	.0046	.21	.0010	.0002	.48	1.0
32072	July 18	V. slight.	Cons.	.14	3.60	1.35	.0208	.0264	.0200	.0064	.32	.0000	.0004	.29	1.3
32662	Aug. 27	Decided.	Cons.	.18	4.30	0.85	.0070	.0284	.0192	.0092	.36	.0040	.0003	.32	1.6
33089	Sept. 26	V. slight.	Slight.	.21	4.40	1.00	.0152	.0236	.0158	.0078	.41	.0040	.0004	.33	1.3
33415	Oct. 24	V. slight.	Cons.	.29	4.95	1.70	.0160	.0264	.0216	.0048	.36	.0090	.0005	.56	1.4
33827	Nov. 27	Slight.	Slight.	.52	4.15	1.65	.0066	.0222	.0194	.0028	.24	.0120	.0001	.79	1.4
34154	Dec. 19	Slight.	V. slight.	.38	4.35	1.60	.0072	.0222	.0200	.0022	.20	.0160	.0002	.66	1.4

Averages by Years.

-	1888	-	-	.30	3.68	1.08	.0026	.0180	-	-	.18	.0094	.0002	-	-
-	1889	-	-	.30	3.09	0.87	.0030	.0176	.0144	.0032	.17	.0072	.0003	-	-
-	1890	-	-	.33	4.19	1.48	.0046	.0166	.0132	.0034	.17	.0089	.0001	-	1.6
-	1891	-	-	.27	3.79	1.32	.0040	.0152	.0121	.0031	.18	.0110	.0001	-	1.3
-	1892	-	-	.43	4.12	1.47	.0042	.0181	.0152	.0029	.18	.0105	.0001	-	1.4
-	1893	-	-	.42	3.86	1.48	.0057	.0181	.0141	.0040	.20	.0081	.0002	.53	1.1
	1894	-	-	.37	3.70	1.30	.0062	.0167	.0141	.0026	.23	.0063	.0001	.44	1.2
-	1895	-	-	.51	4.34	1.75	.0064	.0249	.0185	.0064	.28	.0071	.0002	.59	1.4
-	1896	-	-	.42	3.98	1.52	.0068	.0220	.0183	.0037	.24	.0087	.0003	.53	1.2
-	1897	-	-	.56	3.84	1.54	.0049	.0228	.0186	.0042	.20	.0067	.0001	.54	1.1
-	1898	-	-	.45	3.90	1.63	.0050	.0212	.0169	.0043	.22	.0058	.0003	.53	1.1
-	1899	-	-	.29	3.99	1.49	.0088	.0232	.0175	.0057	.24	.0056	.0003	.47	1.0
-	1900	-	-	.30	3.96	1.38	.0089	.0224	.0180	.0044	.25	.0060	.0002	.50	1.1

NOTE to analyses of 1900: Odor, generally vegetable or unpleasant, sometimes none.

LAWRENCE.

Chemical Examination of Water from the Merrimack River after passing through the Sand Filter of the Lawrence Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
29973	Jan. 17	V. slight.	None.	.28	4.95	1.55	.0146	.0118	.0116	.0002	.38	.0120	.0002	.33	1.7
30259	Feb. 21	None.	None.	.43	3.75	1.65	.0088	.0110	.0110	.0000	.12	.0060	.0001	.49	1.3
30678	Mar. 21	V. slight.	None.	.40	3.60	1.25	.0110	.0086	.0086	.0000	.18	.0090	.0000	.36	1.1
31034	Apr. 18	None.	None.	.31	3.40	1.30	.0072	.0086	.0084	.0002	.14	.0160	.0000	.34	1.0
31273	May 16	Slight.	Cons.	.25	3.30	1.20	.0058	.0098	.0082	.0016	.18	.0130	.0000	.35	1.3
31795	June 20	Slight.	Slight.	.24	4.05	1.35	.0060	.0098	.0094	.0004	.24	.0070	.0001	.35	1.3
32073	July 18	V. slight.	V. slight.	.12	4.30	1.15	.0042	.0078	.0074	.0004	.35	.0090	.0002	.30	1.3
32663	Aug. 27	Decided.	Cons.	.11	4.50	0.80	.0080	.0112	.0092	.0020	.37	.0040	.0002	.15	1.4
33090	Sept. 26	Slight.	Cons.	.00	5.60	1.00	.0515	.0125	.0095	.0030	.48	.0310	.0004	.12	3.1
33416	Oct. 24	None.	None.	.30	4.90	1.20	.0068	.0124	.0110	.0014	.35	.0290	.0000	.39	1.4
33828	Nov. 27	Slight.	Slight.	.44	4.50	1.35	.0134	.0118	.0102	.0016	.26	.0390	.0002	.44	1.8
34155	Dec. 19	None.	None.	.44	4.70	1.55	.0100	.0144	.0142	.0002	.25	.0330	.0000	.57	1.6

Averages by Years.

-	1894	-	-	.39	6.10	1.41	.0103	.0094	.0081	.0013	.30	.0309	.0002	.29	2.8
-	1895	-	-	.50	5.95	1.70	.0146	.0108	.0094	.0014	.31	.0274	.0001	.36	2.7
-	1896	-	-	.40	5.43	1.64	.0121	.0099	.0079	.0020	.25	.0319	.0004	.32	2.4
-	1897	-	-	.56	5.17	1.68	.0123	.0108	.0095	.0013	.25	.0317	.0002	.38	2.0
-	1898	-	-	.43	4.66	1.69	.0107	.0090	.0084	.0006	.26	.0324	.0001	.35	1.9
-	1899	-	-	.27	4.44	1.42	.0087	.0089	.0083	.0006	.28	.0205	.0001	.30	1.6
-	1900	-	-	.28	4.30	1.28	.0123	.0108	.0099	.0009	.27	.0173	.0001	.35	1.5

NOTE to analyses of 1900: Odor, generally none, sometimes faintly vegetable or unpleasant.

LAWRENCE.

Chemical Examination of Water from the Distributing Reservoir of the Lawrence Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
29974	Jan. 17	V. slight.	None.	.25	5.15	1.60	.0118	.0110	.0104	.0006	.38	.0110	.0002	.32	1.7
30260	Feb. 21	V. slight.	None.	.39	4.05	1.55	.0078	.0126	.0122	.0004	.19	.0110	.0001	.43	1.3
30679	Mar. 21	V. slight.	V. slight.	.32	3.40	1.20	.0058	.0096	.0086	.0010	.19	.0060	.0000	.35	1.0
31035	Apr. 18	Slight.	Slight.	.23	3.40	1.15	.0048	.0104	.0100	.0004	.15	.0070	.0000	.30	1.0
31274	May 16	V. slight.	Slight.	.21	3.30	0.90	.0008	.0100	.0090	.0010	.17	.0300	.0000	.30	1.3
31796	June 20	V. slight.	V. slight.	.20	3.85	1.30	.0022	.0118	.0106	.0012	.20	.0070	.0001	.35	1.1
32074	July 18	V. slight.	V. slight.	.08	4.35	1.30	.0018	.0084	.0078	.0006	.32	.0130	.0002	.29	1.6
32664	Aug. 27	V. slight.	V. slight.	.06	4.50	0.80	.0022	.0092	.0080	.0012	.39	.0290	.0003	.15	1.6
33091	Sept. 26	V. slight.	V. slight.	.10	4.40	1.00	.0008	.0074	.0074	.0000	.41	.0340	.0001	.15	1.6
33417	Oct. 24	V. slight.	Slight.	.12	5.10	1.25	.0010	.0098	.0096	.0002	.36	.0250	.0001	.23	1.4
33829	Nov. 27	V. slight.	V. slight.	.34	4.45	1.45	.0042	.0122	.0118	.0004	.31	.0250	.0000	.46	1.8
34156	Dec. 19	None.	Slight.	.40	4.70	1.50	.0058	.0156	.0148	.0008	.28	.0290	.0000	.56	1.7
Av...	....	....	....	.22	4.22	1.25	.0041	.0107	.0100	.0007	.28	.0189	.0001	.32	1.4

Odor in September, faintly unpleasant; at other times, vegetable or none. —— The first two samples were collected from the reservoir; the others, from a faucet at the gate-house, representing water flowing out of the reservoir.

Water Supply of Lee. — Berkshire Water Company.

Chemical Examination of Water from the Upper Reservoir of the Berkshire Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sedimen	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30947	Apr. 9	V. slight.	V. slight.	.13	2.50	0.85	.0008	.0082	.0080	.0002	.08	.0020	.0000	0.32	0.5
32040	July 15	V. slight.	Slight.	.42	2.80	1.60	.0054	.0296	.0200	.0096	.08	.0010	.0000	0.73	0.2
33225	Oct. 7	Slight.	Cons.	.80	3.15	1.95	.0052	.0448	.0352	.0096	.09	.0010	.0000	1.19	0.2
34217	Dec. 24	V. slight.	Slight.	.21	2.25	0.75	.0112	.0494	.0316	.0178	.15	.0070	.0000	0.50	0.6
Av...	....	....	....	.39	2.67	1.29	.0056	.0330	.0237	.0093	.10	.0027	.0000	0.68	0.4

Odor of the first sample, none, becoming faintly vegetable on heating; of the second, distinctly oily; of the third, faintly vegetable, becoming decidedly unpleasant on heating; of the last, faintly vegetable, becoming distinctly disagreeable and fishy on heating.

Microscopical Examination.

An insignificant number of organisms was found in the first sample. The organism *Uroglena* was found in the second and third samples and *Dinobryon* in considerable numbers in the last sample.

LEE.

Chemical Examination of Water from the Lower Reservoir of the Berkshire Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1900.														
30948	Apr. 9	V. slight.	V. slight.	.12	2.50	0.85	.0010	.0086	.0082	.0004	.07	.0030	.0000	.29	0.5
32041	July 15	V. slight.	V. slight.	.32	3.55	1.40	.0018	.0104	.0100	.0004	.06	.0020	.0000	.45	2.2
33226	Oct. 7	None.	Slight.	.52	4.00	1.75	.0008	.0166	.0160	.0006	.08	.0030	.0000	.72	1.7
34218	Dec. 24	None.	V. slight.	.21	2.65	0.75	.0016	.0136	.0120	.0016	.09	.0280	.0000	.48	1.1
Av...	....	....	....	.29	3.17	1.19	.0013	.0123	.0115	.0008	.07	.0090	.0000	.48	1.4

Odor, faintly vegetable or none.

Water Supply of Leicester Water Supply District, Leicester.

Chemical Examination of Water from the Wells of the Leicester Water Supply District.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30142	Feb. 7	None.	None.	.00	4.50	.0000	.0008	.24	.1240	.0000	.02	1.7	.0020
31157	May 2	None.	V. slight.	.09	5.00	.0018	.0050	.19	.0410	.0000	.20	1.4	.0020
32430	Aug. 8	None.	V. slight.	.00	5.10	.0000	.0026	.22	.0820	.0000	.07	2.1	.0040
33612	Nov. 7	None.	None.	.00	5.80	.0004	.0018	.28	.1190	.0000	.02	1.8	.0020
Av...	....	....	....	.02	5.10	.0005	.0025	.23	.0915	.0000	.08	1.7	.0025

Odor of the second sample, faintly vegetable; of the others, none.

LENOX.

Water Supply of Lenox. — Lenox Water Company.

Chemical Examination of Water from the Storage Reservoir of the Lenox Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
31303	May 17	Slight.	Slight.	.04	6.65	0.70	.0016	.0150	.0126	.0024	.09	.0020	.0001	.14	4.3
31890	June 27	None.	V. slight.	.00	8.10	1.05	.0026	.0148	.0104	.0044	.09	.0000	.0000	.17	6.0
32716	Aug. 29	V. slight.	Slight.	.04	8.00	0.90	.0038	.0220	.0192	.0028	.06	.0010	.0000	.19	6.0
33794	Nov. 22	V. slight.	V. slight.	.10	9.75	1.25	.0028	.0120	.0114	.0006	.15	.0060	.0000	.28	7.1
Av...	....	....	....	.04	8.12	0.97	.0027	.0159	.0134	.0025	.10	.0022	.0000	.19	5.8

Odor, none. A faintly vegetable odor was developed in the first, and a very faintly unpleasant odor in the third, sample on heating. —— The samples were collected from the reservoir on Williams River.

The advice of the State Board of Health to the board of health of Lenox, relative to the quality of water of a well in that town, used by a considerable number of people for drinking purposes, may be found on page 24 of this volume. The results of an analysis of a sample of water collected from the well are given in the following table: —

Chemical Examination of Water from a Large Well near Lily Pond in Lenox.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1900.												
33854	Nov. 30	None.	V. slight.	.00	21.20	.0000	.0020	.15	.0960	.0000	.01	18.8	.0020

Odor, none.

LEOMINSTER.

WATER SUPPLY OF LEOMINSTER.

Chemical Examination of Water from Haynes Reservoir, Leominster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30362	Mar. 2	V. slight.	V. slight.	.08	1.20	0.50	.0000	.0060	.0052	.0008	.04	.0010	.0001	.21	0.0
31362	May 23	Slight.	Cons.	.15	1.90	0.90	.0004	.0284	.0194	.0090	.10	.0030	.0001	.33	0.3
32602	Aug. 22	Decided.	Heavy.	.17	2.10	0.85	.0004	.0484	.0284	.0200	.12	.0020	.0000	.46	0.0
33818	Nov. 27	V. slight.	Slight.	.24	2.30	1.20	.0058	.0388	.0266	.0122	.15	.0020	.0000	.50	0.0
Av...	....	....	....	.16	1.87	0.86	.0016	.0304	.0199	.0105	.10	.0020	.0000	.37	0.1

Odor of the first and last samples, none, becoming fishy on heating; of the others, vegetable.

Chemical Examination of Water from Morse Reservoir, Leominster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30363	Mar. 2	V. slight.	V. slight.	.24	1.95	0.85	.0000	.0102	.0082	.0020	.09	.0010	.0001	.37	0.0
31363	May 23	V. slight.	Slight.	.16	1.85	0.80	.0010	.0168	.0134	.0034	.10	.0050	.0000	.34	0.5
32603	Aug. 22	Slight.	Cons.	.22	2.00	0.80	.0010	.0262	.0182	.0080	.13	.0020	.0000	.38	0.0
33819	Nov. 27	Slight.	Slight.	.31	2.60	1.00	.0010	.0260	.0204	.0056	.17	.0040	.0000	.61	0.5
Av...	....	....	....	.23	2.10	0.86	.0007	.0198	.0150	.0048	.12	.0030	.0000	.42	0.2

Odor of the last sample, faintly unpleasant; of the others, faintly vegetable or none.

LEOMINSTER.

Chemical Examination of Water from Fall Brook above the Fall Brook Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30036	Jan. 24	V. slight.	V. slight.	.42	3.65	1.55	.0010	.0150	.0148	.0002	.20	.0050	.0000	0.71	0.2
30361	Mar. 2	V. slight.	V. slight.	.28	2.10	1.05	.0004	.0072	.0068	.0004	.08	.0010	.0000	0.42	0.0
30833	Mar. 28	V. slight.	Slight.	.40	2.10	1.05	.0000	.0122	.0098	.0024	.14	.0010	.0001	0.53	0.2
31084	Apr. 25	V. slight.	Slight.	.36	2.25	1.05	.0000	.0184	.0176	.0008	.14	.0010	.0000	0.60	0.0
31359	May 23	V. slight.	V. slight.	.12	2.15	0.70	.0002	.0164	.0146	.0018	.11	.0050	.0001	0.35	0.2
31862	June 27	Slight.	Cons.	.07	1.90	1.00	.0008	.0162	.0140	.0022	.14	.0010	.0000	0.28	0.0
32339	Aug. 1	V. slight.	Slight.	.06	2.05	1.00	.0006	.0156	.0136	.0020	.12	.0010	.0000	0.24	0.0
32599	Aug. 22	V. slight.	Slight.	.05	1.85	0.75	.0002	.0168	.0138	.0030	.13	.0000	.0000	0.21	0.2
33093	Sept. 26	V. slight.	V. slight.	.09	1.80	0.90	.0004	.0166	.0148	.0018	.13	.0040	.0000	0.22	0.0
33507	Oct. 30	V. slight.	Cons.	.25	3.20	0.85	.0008	.0228	.0154	.0074	.25	.0020	.0000	0.51	0.3
33815	Nov. 27	V. slight.	V. slight.	.70	3.60	1.20	.0012	.0192	.0184	.0008	.19	.0060	.0000	1.04	0.6
34224	Dec. 26	None.	Slight.	.36	3.00	1.25	.0014	.0118	.0114	.0004	.14	.0040	.0000	0.63	0.3

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1897	-	-	.61	3.01	1.49	.0006	.0135	.0126	.0009	.16	.0041	.0000	0.60	0.5
-	1898	-	-	.46	2.54	1.30	.0005	.0129	.0114	.0015	.13	.0035	.0000	0.50	0.6
-	1899	-	-	.20	2.45	1.03	.0006	.0151	.0129	.0022	.14	.0017	.0000	0.38	0.2
-	1900	-	-	.26	2.47	1.03	.0006	.0157	.0138	.0019	.15	.0026	.0000	0.48	0.2

NOTE to analyses of 1900: Odor, vegetable or none. A faintly fishy odor was developed in No. 32599 on heating.

Chemical Examination of Water from Fall Brook Reservoir, Leominster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30037	Jan. 24	V. slight.	V. slight.	.06	2.05	0.90	.0006	.0164	.0154	.0010	.16	.0020	.0000	.23	0.0
30326	Feb. 27	V. slight.	V. slight.	.19	2.25	1.10	.0014	.0188	.0152	.0036	.13	.0010	.0000	.40	0.0
30834	Mar. 28	V. slight.	Cons.	.14	1.95	0.90	.0048	.0162	.0134	.0028	.15	.0060	.0001	.31	0.2
31085	Apr. 25	V. slight.	Slight.	.11	1.70	0.60	.0000	.0146	.0114	.0032	.12	.0010	.0000	.32	0.2
31360	May 23	V. slight.	Cons.	.13	2.00	0.75	.0006	.0164	.0120	.0044	.11	.0020	.0000	.35	0.3
31863	June 27	Slight.	Cons.	.09	1.80	0.95	.0006	.0166	.0148	.0018	.12	.0050	.0000	.29	0.0
32340	Aug. 1	V. slight.	Slight.	.04	1.95	0.85	.0000	.0170	.0142	.0028	.11	.0010	.0000	.24	0.0
32600	Aug. 22	V. slight.	Slight.	.04	1.80	0.75	.0004	.0158	.0130	.0028	.13	.0020	.0000	.22	0.0
33094	Sept. 26	V. slight.	Slight.	.07	2.25	1.25	.0002	.0162	.0140	.0022	.12	.0030	.0000	.24	0.0
33508	Oct. 30	V. slight.	Slight.	.05	2.15	0.90	.0004	.0174	.0154	.0020	.15	.0030	.0000	.27	0.0
33816	Nov. 27	V. slight.	Slight.	.06	2.05	0.70	.0010	.0156	.0124	.0032	.16	.0030	.0000	.29	0.2
34225	Dec. 26	None.	Slight.	.10	1.90	0.80	.0014	.0152	.0126	.0026	.14	.0040	.0000	.46	0.3

LEOMINSTER.

Chemical Examination of Water from Fall Brook Reservoir, Leominster — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
-	1897	-	-	.36	2.96	1.39	.0026	.0200	.0160	.0040	.20	.0033	.0000	.45	0.6
-	1898	-	-	.26	2.35	1.16	.0011	.0169	.0139	.0030	.16	.0037	.0001	.35	0.5
-	1899	-	-	.11	1.95	0.92	.0007	.0161	.0133	.0028	.13	.0015	.0000	.26	0.2
-	1900	-	-	.09	1.99	0.87	.0009	.0163	.0136	.0027	.13	.0027	.0000	.30	0.1

Note to analyses of 1900: Odor of No. 31863, faintly unpleasant; of the others, faintly vegetable or none. A faintly fishy odor was developed in No. 32600 on heating. —— The samples were collected from the reservoir, at the gate-house, 1 foot beneath the surface.

Microscopical Examination of Water from Fall Brook Reservoir, Leominster.

[Number of organisms per cubic centimeter.]

	1900. Jan.	Feb.	Mar.	Apr.	May.	June.	Aug.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	25	28	28	26	24	28	2	23	27	31	28	27
Number of sample,	30037	30326	30834	31085	31360	31863	32340	32600	33094	33508	33816	34225
PLANTS.												
Diatomaceæ,	**0**	**9**	**4**	**134**	**617**	**654**	**21**	**130**	**95**	**67**	**35**	**8**
Asterionella,	0	0	4	6	14	652	5	0	0	0	0	0
Tabellaria,	0	9	0	128	556	2	16	130	95	63	35	6
Algæ,	**0**	**0**	**0**	**4**	**5**	**20**	**36**	**20**	**3**	**5**	**1**	**1**
ANIMALS.												
Rhizopoda, Actinophrys,	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
Infusoria,	**282**	**244**	**380**	**189**	**18**	**1**	**125**	**748**	**0**	**7**	**14**	**152**
Dinobryon,	280	241	374	175	18	0	124	748	0	0	0	147
Peridinium,	1	3	5	4	0	1	0	0	0	7	11	4
Uroglena,	0	0	1	10	0	0	0	0	0	0	0	0
Vermes,	**0**	**1**	**2**	**0**	**4**	**2**	**0**	**0**	**0**	**1**	**0**	**0**
Crustacea, Cyclops,	**0**	**0**	**pr.**	**0**	**0**	**0**	**pr.**	**0**	**0**	**pr.**	**0**	**pr.**
Miscellaneous, Zoöglœa,	**3**	**5**	**5**	**3**	**5**	**5**	**3**	**10**	**5**	**5**	**5**	**5**
Total,	285	259	391	330	649	682	185	908	103	86	55	166

LEOMINSTER.

Chemical Examination of Water from Fall Brook Reservoir, Leominster, collected near the Bottom.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.	Albuminoid.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
30038	Jan. 24	V. slight.	Slight.	.05	2.15	0.85	.0026	.0192	.0162	.0030	.17	.0010	.0000	.23	0.2
30327	Feb. 27	V. slight.	Slight.	.20	2.05	1.15	.0002	.0196	.0148	.0048	.13	.0020	.0000	.40	0.0
30835	Mar. 28	V. slight.	Cons.	.18	1.95	0.95	.0008	.0162	.0124	.0038	.14	.0020	.0000	.39	0.2
31086	Apr. 25	V. slight.	Slight.	.12	2.00	0.75	.0006	.0144	.0114	.0030	.13	.0010	.0000	.38	0.0
31361	May 23	V. slight.	Cons.	.12	2.00	0.80	.0006	.0162	.0124	.0038	.12	.0050	.0000	.35	0.2
31864	June 27	Slight.	Cons.	.08	1.80	1.00	.0010	.0170	.0134	.0036	.13	.0010	.0000	.28	0.0
32341	Aug. 1	V. slight.	Slight.	.05	1.95	0.80	.0000	.0138	.0114	.0024	.11	.0000	.0000	.24	0.0
32601	Aug. 22	V. slight.	Cons.	.04	2.00	0.75	.0002	.0162	.0128	.0034	.12	.0010	.0000	.27	0.2
33095	Sept. 26	V. slight.	Slight.	.06	1.75	0.85	.0000	.0162	.0126	.0036	.12	.0000	.0000	.27	0.0
33509	Oct. 30	V. slight.	Slight.	.10	1.95	0.60	.0006	.0170	.0138	.0032	.15	.0020	.0000	.28	0.0
33817	Nov. 27	V. slight.	Slight.	.08	2.00	0.75	.0016	.0166	.0118	.0048	.16	.0010	.0000	.30	0.2
34226	Dec. 26	V. slight.	Cons.	.12	2.10	0.85	.0026	.0180	.0130	.0050	.14	.0080	.0000	.45	0.2
Av...	....	....	....	.10	1.97	0.84	.0009	.0167	.0130	.0037	.13	.0020	.0000	.32	0.1

Odor, faintly unpleasant or none, becoming stronger, and occasionally also unpleasant or fishy, on heating. —— The samples were collected from the reservoir, at the gate-house, about 1 foot from the bottom.

WATER SUPPLY OF LEXINGTON.

Chemical Examination of Water from the Vine Brook Storage Reservoir of the Lexington Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.	Albuminoid.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
30055	Jan. 29	Decided.	V. slight.	.33	5.75	2.90	.0002	.0340	.0260	.0080	.30	.0010	.0001	.87	1.0
30905	Apr. 2	Decided.	Cons.	.21	4.30	1.70	.0018	.0294	.0176	.0118	.32	.0070	.0001	.46	1.1
31354	May 23	Decided.	Cons.	.21	3.95	1.00	.0010	.0442	.0204	.0238	.38	.0040	.0001	.48	1.3
32144	July 25	Decided.	Cons.	.18	5.25	1.00	.0008	.0352	.0216	.0136	.39	.0020	.0003	.49	2.0
32987	Sept. 19	Decided.	Cons.	.26	6.10	2.50	.0005	.0570	.0316	.0254	.47	.0610	.0004	.54	1.4
33745	Nov. 21	Decided.	Cons.	.38	6.85	2.40	.0010	.0622	.0410	.0212	.45	.0050	.0000	.68	2.1
Av...	....	....	....	.26	5.37	1.92	.0009	.0437	.0264	.0173	.38	.0133	.0002	.59	1.5

Odor of the first and last samples, none, becoming vegetable on heating; of the others, unpleasant.

LEXINGTON.

Chemical Examination of Water from the Wells of the Lexington Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1900.														
30056	Jan. 29	V. slight.	None.	0.37	10.95	4.15	.0008	.0200	.0198	.0002	.52	.1400	.0001	0.79	4.2
30906	Apr. 2	None.	None.	0.02	5.00	–	.0002	.0026	–	–	.41	.0690	.0000	0.12	1.8
31353	May 23	V. slight.	V. slight.	1.30	9.00	3.65	.0014	.0276	.0276	.0000	.60	.1640	.0000	2.55	3.5
32145	July 25	Slight.	Slight.	0.10	8.35	1.00	.0000	.0140	.0104	.0036	.47	.0300	.0000	0.25	4.7
32988	Sept 19	V. slight.	Slight.	0.20	4.30	1.55	.0006	.0178	.0150	.0028	.27	.0050	.0000	0.36	1.6
33746	Nov. 21	V. slight.	V. slight.	0.12	8.75	1.70	.0014	.0090	.0084	.0006	.49	.0450	.0000	0.21	4.2
Av...	....	....	....	0.35	7.72	2.41	.0007	.0152	.0162	.0014	.46	.0755	.0000	0.71	3.3

Odor, none, becoming faintly unpleasant in the first sample on heating.——The samples were collected from a faucet at the pumping station.

Chemical Examination of Water from Faucets in Lexington.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1900.														
30057	Jan. 29	V. slight.	V. slight.	.37	10.85	4.10	.0006	.0212	.0194	.0018	.46	.0850	.0001	0.80	4.3
30907	Apr. 2	V. slight.	Slight.	.73	7.65	2.85	.0028	.0176	.0164	.0012	.52	.0950	.0001	0.81	3.3
31355	May 23	V. slight.	V. slight.	.72	10.15	3.50	.0010	.0238	.0238	.0000	.61	.1550	.0000	1.15	5.1
32146	July 25	Slight.	V. slight.	.12	8.05	1.50	.0000	.0174	.0128	.0046	.47	.0270	.0000	0.28	4.2
32989	Sept. 19	V. slight.	V. slight.	.16	3.65	1.30	.0002	.0168	.0142	.0026	.24	.0020	.0000	0.31	1.0
33747	Nov. 21	V. slight.	Slight.	.22	9.10	1.80	.0012	.0102	.0094	.0008	.55	.0690	.0000	0.31	4.4
Av...	....	....	....	.39	8.24	2.51	.0010	.0178	.0160	.0018	.47	.0722	.0000	0.61	3.7

Odor, none, becoming faintly vegetable or unpleasant on heating.——The samples were collected from faucets in the town, and represent water from the wells after passing through a mechanical filter.

Water Supply of Lincoln.

(See also *Concord.*)

The advice of the State Board of Health to the board of health of Lincoln, relative to the quality of the water of the distributing reservoir of the Lincoln Water Works and the quality of the water of a well in Lincoln which has been used extensively for drinking purposes by a number of families, may be found on page 25 of this volume. The results of analyses of samples of water collected during the investigation are given in the following tables :—

LINCOLN.

Chemical Examination of Water from the Distributing Reservoir of the Lincoln Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
33114	1900. Sept. 27	None.	V. slight.	.00	2.00	0.70	.0008	.0146	.0134	.0012	.26	.0010	.0000	.14	0.2

Odor, faintly vegetable, becoming stronger on heating.

Chemical Examination of Water from a Well in Lincoln.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
33115	1900. Sept. 27	Decided.	Cons.	.10	14.80	.0928	.0364	1.59	.0470	.0280	.35	3.8	.0360

Odor, distinctly disagreeable. —— The sample was collected from a well on the premises of Julia A. Bemis.

Water Supply of Longmeadow.

Chemical Examination of Water from Cooley Brook, Longmeadow.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
30837	1900. Mar. 28	V. slight.	V. slight.	.04	3.80	1.25	.0008	.0040	.0036	.0004	.17	.0200	.0003	.11	2.1
31883	June 26	None.	V. slight.	.04	4.55	0.95	.0026	.0054	.0048	.0006	.18	.0310	.0002	.11	2.6
33107	Sept. 25	V. slight.	V. slight.	.06	5.60	1.00	.0014	.0032	.0032	.0000	.21	.0380	.0002	.08	3.0
34244	Dec. 26	V. slight.	Slight.	.01	4.80	0.95	.0012	.0038	.0026	.0012	.21	.0420	.0000	.07	2.7
Av...	....	....	....	.04	4.69	1.04	.0015	.0041	.0035	.0006	.19	.0327	.0002	.09	2.6

Odor of the first sample, none; of the others, none, becoming faintly vegetable on heating.

Water Supply of Lowell.

The advice of the State Board of Health to the city of Lowell, relative to an additional water supply for that city, may be found on pages 25 to 27 of this volume. The results of analyses of samples of water collected during the investigations, together with the results of analyses of samples collected from the present sources of supply, are given in the following tables: —

Chemical Examination of Water from the Merrimack River above Lowell.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
29956	Jan. 16	Decided.	Slight.	.15	3.90	1.30	.0086	.0214	.0166	.0048	.22	.0060	.0002	.40	0.8
30243	Feb. 20	V. slight.	Slight.	.37	3.05	1.50	.0024	.0190	.0166	.0024	.12	.0020	.0001	.66	0.8
30639	Mar. 20	Slight.	Cons.	.32	3.05	1.25	.0010	.0170	.0144	.0026	.15	.0050	.0001	.48	0.5
31140	Apr. 30	Slight.	Cons.	.28	3.15	1.10	.0008	.0144	.0114	.0030	.09	.0050	.0001	.44	0.6
31260	May 15	V. slight.	Slight.	.29	3.15	1.30	.0026	.0162	.0142	.0020	.14	.0060	.0002	.45	0.8
31773	June 19	Slight.	Cons.	.24	3.00	1.10	.0034	.0214	.0144	.0070	.13	.0020	.0002	.43	1.0
32052	July 17	Slight.	Slight.	.11	3.15	0.90	.0040	.0222	.0154	.0068	.24	.0020	.0002	.33	1.8
32606	Aug. 22	Slight.	Slight.	.10	3.50	1.00	.0028	.0192	.0136	.0056	.27	.0050	.0003	.34	1.3
32969	Sept. 18	Slight.	Slight.	.23	3.95	1.05	.0088	.0200	.0166	.0034	.28	.0020	.0003	.32	1.6
33422	Oct. 23	None.	Cons.	.28	4.50	1.60	.0128	.0224	.0166	.0058	.22	.0030	.0002	.50	1.0
33720	Nov. 20	Slight.	Slight.	.45	4.20	1.60	.0088	.0240	.0184	.0056	.25	.0090	.0001	.71	1.3
34136	Dec. 18	V. slight.	V. slight.	.40	4.00	1.50	.0068	.0188	.0164	.0024	.21	.0120	.0001	.63	1.3

Averages by Years.

-	1888	-	-	.30	3.42	0.97	.0016	.0148	-	-	.16	.0099	.0002	-	-
-	1889	-	-	.28	2.95	0.84	.0018	.0149	.0126	.0023	.14	.0071	.0002	-	-
-	1890	-	-	.30	3.57	1.54	.0014	.0128	.0104	.0024	.13	.0111	.0001	-	1.4
-	1891	-	-	.29	3.43	1.23	.0017	.0129	.0100	.0029	.13	.0137	.0001	-	1.2
-	1892	-	-	.39	3.61	1.36	.0021	.0141	.0113	.0028	.14	.0092	.0001	-	1.3
-	1893	-	-	.33	3.39	1.18	.0026	.0149	.0120	.0029	.17	.0083	.0001	.44	1.1
-	1894	-	-	.35	3.55	1.26	.0034	.0135	.0109	.0026	.18	.0063	.0001	.40	1.1
-	1895	-	-	.41	3.84	1.46	.0039	.0187	.0140	.0047	.21	.0066	.0001	.54	1.2
-	1896	-	-	.40	3.47	1.28	.0034	.0167	.0136	.0031	.17	.0070	.0001	.52	1.0
-	1897	-	-	.50	3.54	1.46	.0030	.0177	.0153	.0024	.15	.0067	.0001	.52	1.0
-	1898	-	-	.42	3.53	1.56	.0026	.0173	.0150	.0023	.17	.0048	.0001	.49	1.0
-	1899	-	-	.27	3.60	1.42	.0050	.0187	.0152	.0035	.18	.0060	.0002	.42	0.9
-	1900	-	-	.27	3.55	1.27	.0052	.0197	.0154	.0043	.19	.0049	.0002	.47	1.1

Note to analyses of 1900: Odor, generally vegetable, sometimes unpleasant or musty. —— The samples were collected from the river, opposite the intake of the Lowell water works. The water of the Merrimack River was not used directly for the supply of the city during the year 1900.

LOWELL.

Chemical Examination of Water from Tubular Wells in the Valley of River Meadow Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29958	Jan. 16	V. slight.	V. slight.	.06	8.60	.0026	.0036	.52	.0270	.0000	.12	3.3	.0250
30245	Feb. 20	V. slight.	V. slight.	.05	9.00	.0040	.0044	.47	.0270	.0001	.11	3.5	.0300
30641	Mar. 20	V. slight.	V. slight.	.06	8.70	.0036	.0038	.45	.0310	.0001	.11	3.5	.0360
31142	Apr. 30	V. slight.	V. slight.	.10	9.30	.0038	.0036	.48	.0270	.0001	.13	3.8	.0420
31262	May 15	Slight.	Slight.	.12	9.60	.0036	.0042	.44	.0270	.0001	.12	4.0	.0760
31775	June 19	None.	None.	.05	8.40	.0010	.0078	.53	.0520	.0001	.10	3.8	.0060
32054	July 17	V. slight.	V. slight.	.10	8.70	.0046	.0040	.44	.0210	.0000	.14	4.0	.0310
32608	Aug. 22	None.	V. slight.	.02	8.60	.0014	.0042	.51	.0340	.0000	.11	3.6	.0050
33031	Sept. 20	None.	None.	.02	9.00	.0008	.0036	.50	.0350	.0000	.08	3.5	.0070
33424	Oct. 23	None.	V. slight.	.04	8.20	.0016	.0056	.50	.0340	.0000	.07	3.4	.0080
33722	Nov. 20	V. slight.	V. slight.	.03	9.00	.0012	.0064	.50	.0450	.0000	.09	3.3	.0200
34138	Dec. 18	None.	V. slight.	.00	9.20	.0014	.0058	.50	.0480	.0000	.12	3.9	.0100

Averages by Years.

-	1894	-	-	.02	7.33	.0003	.0014	.55	.0549	.0002	.02	2.8	.0078
-	1895	-	-	.02	9.22	.0001	.0024	.56	.0323	.0002	.05	3.8	.0119
-	1896	-	-	.02	8.37	.0002	.0035	.53	.0507	.0000	.09	3.8	.0068
-	1897	-	-	.02	8.71	.0008	.0035	.55	.0378	.0001	.08	3.7	.0041
-	1898	-	-	.06	9.02	.0002	.0038	.56	.0392	.0000	.10	3.9	.0056
-	1899	-	-	.08	8.55	.0020	.0045	.47	.0248	.0000	.12	3.4	.0139
-	1900	-	-	.05	8.86	.0025	.0047	.49	.0340	.0000	.11	3.6	.0247

NOTE to analyses of 1900: Odor, none. —— The samples were collected from a tap at the pumping station a short distance above Plain Street, and generally represent water from the "Cook" wells, mixed with water from a group of wells further up the valley, known as the "Hydraulic" wells.

LOWELL.

Chemical Examination of Water from Tubular Wells in the Valley of the Merrimack River near the Pawtucket Boulevard.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29957	Jan. 16	V. slight.	Slight.	.05	4.60	.0090	.0026	.30	.0270	.0000	.09	2.0	.0630
30244	Feb. 20	V. slight.	V. slight.	.10	4.50	.0088	.0032	.29	.0220	.0000	.10	1.7	.0580
30640	Mar. 20	V. slight.	V. slight.	.10	4.10	.0100	.0036	.24	.0210	.0000	.11	1.7	.0680
31141	Apr. 30	V. slight.	V. slight.	.18	4.20	.0102	.0032	.19	.0260	.0001	.14	1.3	.0520
31261	May 15	Slight.	Slight.	.13	4.00	.0104	.0024	.20	.0200	.0001	.09	1.3	.0720
31774	June 19	V. slight.	Slight.	.10	4.00	.0090	.0066	.22	.0130	.0002	.10	1.6	.0440
32053	July 17	V. slight.	V. slight.	.10	4.00	.0080	.0042	.25	.0090	.0001	.11	1.3	.0330
32607	Aug. 22	None.	V. slight.	.02	4.30	.0080	.0048	.28	.0060	.0001	.10	1.4	.0630
32970	Sept. 18	Slight.	Slight.	.14	4.70	.0070	.0038	.29	.0050	.0000	.09	1.4	.0660
33423	Oct. 23	V. slight.	Cons.	.12	4.30	.0074	.0048	.30	.0050	.0003	.06	1.4	.0600
33721	Nov. 20	V. slight.	Slight.	.11	4.60	.0094	.0050	.29	.0110	.0003	.07	1.8	.0870
34137	Dec. 18	None.	Slight.	.07	4.20	.0096	.0080	.27	.0140	.0001	.09	2.0	.0430

Averages by Years.

-	1896	-	-	.01	4.36	.0044	.0019	.30	.0452	.0001	.04	1.8	.0098
-	1897	-	-	.09	4.55	.0096	.0032	.24	.0255	.0001	.05	1.8	.0222
-	1898	-	-	.13	4.43	.0105	.0030	.27	.0247	.0000	.08	1.9	.0310
-	1899	-	-	.13	4.56	.0103	.0034	.28	.0203	.0001	.08	1.7	.0388
-	1900	-	-	.10	4.29	.0089	.0043	.26	.0149	.0001	.10	1.6	.0591

NOTE to analyses of 1900: Odor, none.—— The samples were collected from the wells which are locally known as the "Boulevard" wells.

Chemical Examination of Water from Pumping Station Number 1 of the Lowell Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29959	Jan. 16	V. slight.	Slight.	.06	4.50	.0060	.0032	.31	.0450	.0001	.08	1.7	.0240
30246	Feb. 20	V. slight.	None.	.07	4.40	.0066	.0034	.31	.0240	.0000	.09	2.0	.0350
30642	Mar. 20	V. slight.	V. slight.	.06	4.20	.0068	.0036	.29	.0210	.0001	.10	2.0	.0380
31143	Apr. 30	V. slight.	V. slight.	.08	4.20	.0074	.0036	.20	.0310	.0001	.11	1.6	.0400
31263	May 15	V. slight.	V. slight.	.10	4.30	.0082	.0030	.24	.0320	.0000	.10	1.8	.0400
31776	June 19	Slight.	Slight.	.05	4.00	.0060	.0058	.21	.0320	.0002	.10	1.7	.0320
32055	July 17	V. slight.	V. slight.	.07	4.20	.0052	.0034	.26	.0180	.0002	.09	1.4	.0160
32609	Aug. 22	Slight.	Slight.	.10	4.00	.0070	.0054	.29	.0100	.0003	.10	1.7	.0320
33030	Sept. 20	Slight.	Slight.	.11	4.80	.0054	.0046	.29	.0120	.0003	.10	2.1	.1000
33425	Oct. 23	V. slight.	Slight.	.12	4.10	.0064	.0060	.30	.0120	.0003	.07	1.6	.0150
33723	Nov. 20	Slight.	V. slight.	.06	4.70	.0056	.0046	.29	.0170	.0002	.07	2.0	.0360
34139	Dec. 18	None.	Slight.	.08	5.00	.0056	.0040	.29	.0490	.0001	.10	2.3	.0400
Av...	....	....	....	.08	4.37	.0063	.0042	.27	.0252	.0002	.09	1.8	.0373

Odor, none.—— The samples were collected from a tap at the pumping station, and represent water from the "Boulevard" wells.

LOWELL.

Chemical Examination of Water from Test Wells in the Valley of Beaver Brook, above Collinsville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29925	Jan. 11	V. slight.	V. slight.	.03	5.70	.0000	.0006	.21	.0520	.0000	.02	2.0	.0230
29926	Jan. 11	None.	V. slight.	.00	5.00	.0000	.0008	.27	.0070	.0000	.03	1.7	.0050
29927	Jan. 11	Decided.	Heavy.	.07	6.70	.0000	.0010	.24	.0060	.0001	.25	1.3	.0740
29928	Jan. 11	Decided.	Cons.	.01	4.20	.0000	.0014	.23	.0010	.0000	.03	1.0	.0090

Odor, none. —— The samples were collected from the test wells by pumping with a hand pump. The first sample was collected from well numbered 3; the second, from well numbered 4; the third, from well numbered 5; the last, from well numbered 9.

Chemical Examination of Water from Tubular Test Wells on the Northerly Side of the Merrimack River West of the Boulevard Wells.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Carbon Dioxide.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.				
	1900.													
32633	Aug. 24	None.	V. slight.	.00	4.50	.0000	.0006	.40	.0330	.0000	.02	1.6	.0130	-
32809	Sept. 4	None.	V. slight.	.00	4.90	.0000	.0006	.52	.0430	.0006	.01	1.6	.0090	1.675
32634	Aug. 24	None.	V. slight.	.00	7.20	.0000	.0002	.78	.2350	.0000	.02	2.2	.0220	-
32810	Sept. 4	V. slight	Slight.	.00	7.50	.0000	.0004	.84	.2050	.0000	.01	2.1	.0070	2.208
32811	Sept. 4	None.	V. slight.	.00	4.40	.0000	.0004	.38	.0570	.0000	.01	1.1	.0030	1.803
32635	Aug. 24	Decided.	Heavy.	.05	18.20	.0000	.0012	.30	.0000	.0000	.08	0.5	.1250	-
32636	Aug. 24	Slight.	Slight.	.01	5.70	.0000	.0010	.25	.0040	.0000	.03	1.0	.0680	-
32812	Sept. 4	None.	V. slight.	.00	3.50	.0000	.0002	.24	.0030	.0000	.00	0.8	.0030	1.600
32637	Aug. 24	Slight.	Slight.	.00	4.50	.0000	.0000	.20	.0040	.0000	.03	0.8	.0230	-
32813	Sept. 4	None.	V. slight.	.00	3.20	.0000	.0000	.18	.0030	.0000	.00	0.5	.0090	1.436
32814	Sept. 4	Decided.	Cons.	-	7.20	.0000	.0012	.40	.0790	.0001	.08	1.6	.0500	1.936
32815	Sept. 4	V. slight.	Slight.	.00	3.80	.0000	.0006	.23	.0030	.0000	.04	0.8	.0090	1.496
32816	Sept. 4	V. slight.	Cons.	.00	4.60	.0000	.0006	.36	.0590	.0001	.03	1.6	.0180	1.423
32817	Sept. 4	Decided.	Cons.	-	6.50	.0000	.0006	.21	.0090	.0000	.06	1.6	.0680	1.321
32900	Sept. 12	None.	None.	.00	3.50	.0000	.0004	.30	.0210	.0000	.00	1.0	.0040	-
32935	Sept. 14	None.	None.	.00	4.40	.0000	.0000	.35	.0320	.0000	.00	1.3	.0040	-

Odor, generally none. —— The samples collected on August 24 were collected from wells numbered 1, 3, 6, 8 and 11, after pumping for several hours with a hand pump; the samples collected on September 4 were collected in the order given from wells numbered 1, 3, 5, 8, 11, 15, 17, 19 and 21; the last two samples were collected from a pump while pumping from a gang of ten of these wells with a steam pump.

Water Supply of Ludlow.

(See *Springfield*.)

Water Supply of Ludlow Manufacturing Company, Ludlow.

The advice of the State Board of Health to the Ludlow Manufacturing Company, relative to the quality of the water of a tubular well driven beneath the factory of that company, may be found on

LUDLOW MANUFACTURING COMPANY.

page 28 of this volume. The results of an analysis of a sample of water collected from the well are given in the following table: —

Chemical Examination of Water from the Well of the Ludlow Manufacturing Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
32386	1900. Aug. 6	None.	V. slight.	.01	13.60	.0002	.0006	1.04	.4000	.0003	.03	6.4	.0100

Odor, none. —— The well is located beneath Mill No. 8 of the Ludlow Manufacturing Company.

Water Supply of Lynn and Saugus.

Chemical Examination of Water from Breed's Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
29887	Jan. 9	V. slight.	V. slight.	.25	3.35	1.45	.0118	.0222	.0194	.0028	.47	.0040	.0002	.47	0.6
30176	Feb. 13	V. slight.	Cons.	.30	3.55	1.40	.0062	.0192	.0168	.0024	.48	.0080	.0002	.44	0.8
30465	Mar. 13	V. slight.	V. slight.	.35	3.20	1.35	.0006	.0144	.0134	.0010	.48	.0030	.0004	.45	0.8
30953	Apr. 9	V. slight.	V. slight.	.25	3.50	1.30	.0014	.0210	.0198	.0012	.45	.0010	.0001	.43	0.6
31191	May 8	V. slight.	V. slight.	.34	2.95	1.00	.0028	.0262	.0254	.0008	.45	.0020	.0001	.51	0.6
31536	June 11	Slight.	Slight.	.33	3.50	1.20	.0020	.0180	.0162	.0018	.49	.0010	.0001	.51	0.6
31983	July 10	V. slight.	V. slight.	.23	3.45	1.60	.0030	.0224	.0190	.0034	.43	.0010	.0000	.42	0.5
32493	Aug. 14	V. slight.	Slight.	.21	3.15	1.05	.0024	.0232	.0204	.0028	.50	.0000	.0001	.41	0.8
32888	Sept. 11	V. slight.	V. slight.	.20	3.35	1.20	.0022	.0208	.0186	.0022	.50	.0010	.0000	.39	0.8
33240	Oct. 8	V. slight.	Slight.	.21	3.10	1.10	.0040	.0198	.0172	.0026	.50	.0000	.0000	.35	0.8
33635	Nov. 12	V. slight.	V. slight.	.14	3.35	1.15	.0026	.0242	.0226	.0016	.52	.0010	.0000	.32	0.6
34021	Dec. 11	Slight.	Slight.	.38	3.60	1.35	.0062	.0236	.0176	.0060	.52	.0020	.0001	.48	1.1

Averages by Years.

-	1888	-	-	.48	3.71	1.42	.0029	.0227	-	-	.45	.0053	.0001	-	-
-	1889	-	-	.45	3.09	1.02	.0007	.0208	.0165	.0043	.41	.0035	.0001	-	-
-	1890	-	-	.42	3.62	1.51	.0014	.0196	.0155	.0041	.41	.0052	.0001	-	1.1
-	1891	-	-	.35	3.35	1.37	.0009	.0156	.0131	.0025	.40	.0080	.0001	-	0.8
-	1892	-	-	.43	3.65	1.38	.0004	.0220	.0177	.0043	.49	.0055	.0000	-	1.0
-	1893	-	-	.65	3.61	1.41	.0039	.0214	.0181	.0033	.55	.0054	.0001	.51	1.1
-	1894	-	-	.65	3.77	1.47	.0023	.0225	.0191	.0034	.58	.0032	.0000	.53	0.9
-	1895	-	-	.48	3.75	1.48	.0016	.0199	.0171	.0028	.58	.0036	.0001	.50	0.9
-	1896	-	-	.39	3.57	1.36	.0023	.0181	.0152	.0029	.52	.0019	.0001	.47	0.7
-	1897	-	-	.43	4.18	1.45	.0025	.0204	.0170	.0034	.58	.0036	.0000	.47	1.0
-	1898	-	-	.46	3.48	1.54	.0022	.0198	.0172	.0026	.49	.0012	.0001	.53	0.8
-	1899	-	-	.30	3.30	1.39	.0037	.0239	.0207	.0032	.43	.0026	.0000	.47	0.7
-	1900	-	-	.27	3.34	1.26	.0038	.0213	.0189	.0024	.48	.0020	.0001	.43	0.7

NOTE to analyses of 1900: Odor, generally vegetable, occasionally faintly unpleasant. An oily odor was developed in the last two samples on heating.

LYNN AND SAUGUS.

Chemical Examination of Water from Birch Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29886	Jan. 9	Slight.	Slight.	.60	8.20	2.95	.0080	.0332	.0304	.0028	.73	.0130	.0001	.93	2.5
30175	Feb. 13	V. slight.	Slight.	.36	5.90	2.15	.0014	.0226	.0216	.0010	.54	.0070	.0002	.64	1.8
30464	Mar. 13	Slight.	Slight.	.37	4.35	1.65	.0008	.0230	.0172	.0058	.47	.0050	.0001	.57	1.3
30952	Apr. 9	V. slight.	Slight.	.26	4.30	1.75	.0026	.0196	.0182	.0014	.45	.0050	.0001	.46	1.4
31190	May 8	V. slight.	Cons.	.26	3.60	1.05	.0026	.0246	.0196	.0050	.46	.0000	.0002	.50	1.4
31535	June 11	V. slight.	Cons.	.22	4.30	1.30	.0040	.0214	.0200	.0014	.50	.0010	.0001	.41	1.3
31982	July 10	V. slight.	Slight.	.22	3.65	1.15	.0018	.0222	.0190	.0032	.44	.0020	.0000	.42	1.4
32492	Aug. 14	V. slight.	Slight.	.42	4.05	1.50	.0010	.0260	.0222	.0038	.53	.0010	.0000	.45	1.4
32896	Sept. 11	V. slight.	V. slight.	.43	4.25	1.50	.0072	.0264	.0246	.0018	.57	.0010	.0000	.50	1.3
33239	Oct. 8	V. slight.	Cons.	.60	4.10	1.50	.0110	.0288	.0252	.0036	.58	.0020	.0001	.57	1.1

Averages by Years.

-	1888	-	-	.33	3.48	1.40	.0026	.0287	-	-	.45	.0082	.0001	-	-
-	1889	-	-	.23	2.96	1.14	.0014	.0241	.0190	.0051	.41	.0048	.0001	-	-
-	1890	-	-	.36	3.57	1.35	.0013	.0227	.0179	.0048	.42	.0088	.0001	-	1.0
-	1891	-	-	.42	3.26	1.30	.0005	.0241	.0183	.0058	.40	.0065	.0001	-	0.7
-	1892	-	-	.48	3.73	1.56	.0016	.0299	.0227	.0072	.47	.0092	.0001	-	1.0
-	1893	-	-	.75	4.21	1.63	.0052	.0299	.0218	.0081	.51	.0059	.0001	.53	1.0
-	1894	-	-	.75	4.47	1.88	.0053	.0292	.0242	.0050	.57	.0076	.0001	.63	1.1
-	1895	-	-	.60	5.05	2.12	.0031	.0294	.0222	.0072	.70	.0063	.0001	.62	1.4
-	1896	-	-	.45	4.22	1.65	.0018	.0243	.0208	.0035	.58	.0047	.0001	.55	1.1
-	1897	-	-	.50	4.79	1.86	.0029	.0268	.0229	.0039	.65	.0061	.0001	.52	1.6
-	1898	-	-	.28	3.50	1.42	.0017	.0207	.0173	.0034	.55	.0040	.0000	.34	1.0
-	1899	-	-	.21	3.55	1.41	.0036	.0225	.0194	.0031	.46	.0033	.0001	.36	1.0
-	1900	-	-	.37	4.67	1.65	.0040	.0248	.0218	.0030	.53	.0037	.0001	.54	1.5

NOTE to analyses of 1900: Odor, vegetable.

LYNN AND SAUGUS.

Chemical Examination of Water from Walden Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
29891	Jan. 9	Decided.	Slight.	.92	4.45	2.30	.0076	.0356	.0312	.0044	.42	.0080	.0001	.83	0.5
30180	Feb. 13	Slight.	Slight.	.56	3.50	1.55	.0016	.0272	.0206	.0066	.35	.0060	.0001	.67	0.3
30470	Mar. 13	V. slight.	Slight.	.37	3.30	1.45	.0002	.0212	.0178	.0034	.36	.0020	.0001	.51	0.3
30957	Apr. 9	V. slight.	Cons.	.24	3.15	1.45	.0036	.0212	.0144	.0068	.37	.0010	.0003	.44	0.5
31196	May 8	Slight.	Cons.	.30	2.90	1.15	.0010	.0280	.0220	.0060	37	.0000	.0000	.50	0.5
31540	June 11	Slight.	Cons.	.30	4.50	2.00	.0026	.0240	.0182	.0058	.40	.0010	.0000	.50	0.5
31987	July 10	Slight.	Slight.	.32	3.10	1.05	.0076	.0274	.0228	.0046	.35	.0030	.0000	.53	0.5
32497	Aug. 14	Slight.	Cons.	.44	3.15	1.15	.0072	.0364	.0280	.0084	.43	.0090	.0005	.58	0.5
32890	Sept. 11	Slight.	Cons.	.36	3.45	1.40	.0060	.0364	.0294	.0070	.45	.0020	.0000	.58	0.5
33245	Oct. 8	Decided.	Cons.	.31	3.35	1.30	.0052	.0348	.0252	.0096	.44	.0020	.0000	.56	0.6
33639	Nov. 12	Decided.	Cons.	.41	3.10	1.60	.0008	.0444	.0316	.0128	.44	.0010	.0000	.57	0.3
34025	Dec. 11	Decided.	Cons.	.55	4.10	2.05	.0032	.0316	.0230	.0086	.41	.0040	.0001	.79	0.5
Av...	....	....	....	.42	3.50	1.54	.0039	.0307	.0237	.0070	.40	.0032	.0001	.59	0.5

Odor, generally vegetable or unpleasant.

Microscopical Examination of Water from Walden Pond, Lynn.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	10	14	15	11	10	13	12	16	12	10	14	12
Number of sample,	29891	30180	30470	30957	31196	31540	31987	32497	32890	33245	33639	34025
PLANTS.												
Diatomaceæ,	11	199	307	1,151	581	124	1,258	388	991	408	1,856	135
Asterionella,	0	4	0	4	36	24	984	41	0	20	972	78
Melosira,	0	0	0	0	58	12	42	38	286	90	452	21
Synedra,	11	178	294	1,140	486	50	4	4	7	238	76	13
Tabellaria,	0	13	13	7	1	38	226	304	698	60	346	21
Cyanophyceæ,	0	0	0	0	0	1	0	3	4	2	16	0
Aphanocapsa,	0	0	0	0	0	0	0	0	0	1	14	0
Algæ,	0	0	0	15	5	19	4	26	50	11	30	13

LYNN AND SAUGUS.

Microscopical Examination of Water from Walden Pond, Lynn — Concluded.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.												
Infusoria,	12	90	65	277	420	7	96	13	40	374	18	30
Dinobryon,	0	36	40	261	420	0	92	0	0	0	0	0
Monas,	0	0	0	0	0	0	0	0	0	0	10	0
Peridinium,	9	43	18	12	0	1	4	2	18	374	0	28
Trachelomonas,	0	0	0	0	0	3	0	6	18	0	2	2
Uroglena,	0	1	1	1	0	0	0	0	0	0	2	0
Vermes,	1	7	1	1	0	2	0	1	0	0	8	0
Crustacea,	0	0	0	0	0	0	pr.	pr.	0	0	2	0
Cyclops,	0	0	0	0	0	0	pr.	pr.	0	0	0	0
Entomostracan ova,	0	0	0	0	0	0	0	0	0	0	2	0
Miscellaneous, Zoöglœa,	5	5	5	7	7	5	5	10	8	5	10	5
TOTAL,	29	301	378	1,451	1,013	158	1,363	441	1,093	800	1,940	183

Chemical Examination of Water from Glen Lewis Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29888	Jan. 9	Slight.	Slight.	.12	3.45	1.90	.0044	.0338	.0278	.0060	.36	.0020	.0000	.46	0.6
30177	Feb. 13	V. slight.	Slight.	.24	2.95	1.35	.0000	.0238	.0172	.0066	.31	.0040	.0001	.51	0.5
30466	Mar. 13	Slight.	Cons.	.15	2.75	1.35	.0022	0232	.0186	.0046	.35	.0010	.0001	.33	0.5
30954	Apr. 9	V. slight.	Cons.	.07	2.75	1.20	.0000	.0202	.0148	.0054	.34	.0020	.0000	.31	0.5
31192	May 8	Decided.	Cons.	.15	3.25	1.60	.0036	.0494	.0372	.0122	.38	.0000	.0001	.56	0.3
31537	June 11	Slight.	Cons.	.30	3.05	1.15	.0034	.0288	.0204	.0084	.40	.0010	.0000	.41	0.3
31984	July 10	Decided.	Cons.	.48	3.45	1.50	.0042	.0436	.0270	.0166	.35	.0010	.0000	.50	0.3
32494	Aug. 14	Decided.	Cons.	.23	3.35	1.70	.0024	.0860	.0276	.0584	.41	.0000	.0001	.52	0.3
32889	Sept. 11	Decided.	Cons.	.20	3.90	1.80	.0025	.0625	.0272	.0353	.44	.0030	.0000	.51	0.3
33241	Oct. 8	Decided.	Heavy.	.15	3.70	1.75	.0044	.0548	.0264	.0284	.44	.0020	.0000	.46	0.3
33636	Nov. 12	Decided.	Cons.	.17	3.60	1.90	.0096	.0476	.0334	.0142	.41	.0010	.0000	.53	0.2
34022	Dec. 11	Decided.	Cons.	.25	3.50	1.60	.0046	.0390	.0266	.0124	.40	.0020	.0001	.52	0.5
Av...	....	....	....	.21	3.31	1.57	.0034	.0427	.0253	.0174	.38	.0016	.0000	.47	0.4

Odor, generally vegetable, sometimes unpleasant. A fishy odor was developed on heating the sample collected in July.

LYNN AND SAUGUS.

Microscopical Examination of Water from Glen Lewis Pond, Lynn.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	10	14	15	11	9	13	12	16	12	10	13	12
Number of sample,	29888	30177	30466	30954	31192	31537	31984	32494	32889	33241	33636	34022
PLANTS.												
Diatomaceæ,	740	336	12	104	638	162	590	302	279	290	440	71
Asterionella,	16	0	0	4	52	0	12	12	0	28	212	50
Melosira,	0	0	0	18	342	162	570	260	275	254	222	19
Synedra,	724	332	12	81	214	0	8	2	2	6	4	2
Cyanophyceæ,	0	0	0	0	16	62	100	1,746	459	280	24	2
Anabæna,	0	0	0	0	4	0	0	1,376	245	144	0	0
Clathrocystis,	0	0	0	0	12	62	100	368	204	136	24	2
Cœlosphærium,	0	0	0	0	0	0	0	2	10	0	0	0
Algæ,	1	4	4	26	314	34	8	14	0	4	46	19
Scenedesmus,	0	0	0	0	308	0	0	0	0	0	0	0
ANIMALS.												
Infusoria,	12	852	640	201	12	6	20	14	8	22	44	75
Dinobryon,	0	100	588	180	0	0	0	0	0	0	32	35
Euglena,	3	664	12	7	0	0	4	12	0	0	2	6
Peridinium,	7	44	28	7	12	0	0	0	0	0	0	34
Trachelomonas,	0	0	0	0	0	0	16	0	8	22	8	0
Uroglena,	0	44	4	4	0	0	0	0	0	0	2	0
Vermes,	0	4	0	0	4	4	0	0	2	0	0	2
Crustacea,	0	0	0	0	0	pr.	0	0	pr.	0	0	0
Cyclops,	0	0	0	0	0	pr.	0	0	0	0	0	0
Daphnia,	0	0	0	0	0	0	0	0	pr.	0	0	0
Miscellaneous, Zoöglœa,	3	0	10	7	20	10	10	20	10	10	14	5
TOTAL,	756	1,196	666	338	1,004	278	728	2,096	758	606	568	174

LYNN AND SAUGUS.

Chemical Examination of Water from Hawkes Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
29889	Jan. 9	Slight.	V. slight.	.60	8.80	3.05	.0086	.0330	.0300	.0030	.94	.0120	.0002	.98	3.6
30178	Feb. 13	Slight.	Slight.	.70	6.75	2.60	.0052	.0330	.0278	.0052	.52	.0110	.0002	.99	2.2
30467	Mar. 13	V. slight.	Slight.	.48	4.50	1.75	.0006	.0276	.0192	.0084	.46	.0040	.0001	.64	1.3
30955	Apr. 9	V. slight.	Cons.	.33	4.05	1.75	.0022	.0230	.0184	.0046	.43	.0020	.0001	.59	1.1
31193	May 8	Slight.	Cons.	.38	4.30	1.55	.0016	.0272	.0214	.0058	.45	.0010	.0000	.63	1.3
31538	June 11	Slight.	Slight.	.38	4.10	1.15	.0020	.0258	.0224	.0034	.48	.0010	.0000	.64	1.1
31985	July 10	V. slight.	V. slight.	.30	4.20	1.70	.0022	.0280	.0258	.0022	.43	.0010	.0000	.59	1.3
32495	Aug. 14	V. slight.	V. slight.	.23	3.90	1.45	.0022	.0332	.0286	.0046	.47	.0010	.0004	.49	1.1
32898	Sept. 11	V. slight.	Slight.	.18	3.90	1.60	.0036	.0294	.0268	.0026	.50	.0050	.0000	.50	1.3
33242	Oct. 8	Slight.	Cons.	.18	4.15	1.65	.0072	.0308	.0204	.0104	.49	.0010	.0000	.40	1.3
33637	Nov. 12	Slight.	Slight.	.23	4.45	1.75	.0072	.0320	.0252	.0068	.50	.0000	.0000	.42	2.0
34023	Dec. 11	Decided.	Cons.	.44	5.05	1.95	.0052	.0336	.0256	.0080	.49	.0090	.0001	.80	2.7

Averages by Years.

-	1897	-	-	.54	4.64	1.85	.0024	.0242	.0204	.0038	.53	.0098	.0001	.59	1.6
-	1898	-	-	.51	4.02	1.80	.0016	.0227	.0189	.0038	.43	.0044	.0001	.57	1.2
-	1899	-	-	.28	4.10	1.72	.0025	.0259	.0213	.0046	.39	.0043	.0000	.50	1.3
-	1900	-	-	.37	4.85	1.83	.0040	.0297	.0243	.0054	.51	.0040	.0001	.64	1.7

NOTE to analyses of 1900: Odor, generally vegetable, sometimes unpleasant.

Microscopical Examination of Water from Hawkes Pond, Lynn.

[Number of organisms per cubic centimeter.]

	1900. Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	10	14	15	11	9	13	12	16	13	10	13	12
Number of sample,	29889	30178	30467	30955	31193	31538	31985	32495	32898	33242	33637	34023
PLANTS.												
Diatomaceæ,	13	2	2	84	536	92	387	78	39	319	447	506
Asterionella,	3	0	0	0	0	0	202	0	8	267	264	142
Cyclotella,	0	0	0	0	0	0	0	0	7	21	181	362
Synedra,	9	2	2	78	504	0	4	0	1	1	2	1
Tabellaria,	0	0	0	6	32	92	180	78	23	29	0	0
Cyanophyceæ,	0	0	0	0	0	0	0	4	0	3	0	0
Algæ,	0	0	0	0	4	10	23	4	71	20	3	0
Protococcus,	0	0	0	0	0	0	16	0	69	16	0	0

LYNN AND SAUGUS.

Microscopical Examination of Water from Hawkes Pond, Lynn — Concluded.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.												
Infusoria,	25	148	131	219	144	1	0	20	4	59	1,007	292
Dinobryon,	22	84	47	202	0	0	0	0	0	56	1,004	292
Mallomonas,	1	0	0	0	0	0	0	10	0	1	1	0
Peridinium,	2	58	84	0	0	1	0	2	0	1	0	0
Uroglena,	0	2	0	13	144	0	0	0	0	0	0	0
Vermes,	0	0	0	0	0	0	1	1	0	1	0	0
Crustacea, Cyclops,	0	0	0	0	0	0	0	0	0	0	pr.	pr.
Miscellaneous, Zoöglœa,	3	8	5	12	10	5	3	3	3	5	7	5
TOTAL,	41	158	138	315	694	108	414	110	117	407	1,464	803

Chemical Examination of Water from the Saugus River at Montrose.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
29892	Jan. 9	Slight.	Slight.	0.56	9.40	2.90	.0140	.0330	.0296	.0034	.92	.0150	.0003	0.93	3.9
30181	Feb. 13	Slight.	Slight.	0.55	5.20	1.90	.0016	.0294	.0246	.0048	.49	.0050	.0001	0.80	1.6
30469	Mar. 13	V. slight.	Slight.	0.59	6.00	2.55	.0006	.0270	.0244	.0026	.59	.0010	.0002	0.82	2.0
30958	Apr. 9	V. slight.	Cons.	0.60	6.15	2.70	.0020	.0288	.0240	.0048	.58	.0060	.0001	0.82	2.2
31195	May 8	V. slight.	Slight.	1.10	6.30	2.60	.0024	.0304	.0290	.0014	.67	.0070	.0001	1.10	3.0
31541	June 11	Slight.	Slight.	0.70	7.50	3.05	.0028	.0314	.0292	.0022	.70	.0060	.0002	0.82	3.0
31988	July 10	V. slight.	Slight.	0.38	6.75	2.10	.0068	.0248	.0236	.0012	.60	.0030	.0004	0.55	3.1
32498	Aug. 14	Slight.	Slight.	0.32	5.80	1.80	.0112	.0320	.0272	.0048	.48	.0000	.0001	0.53	3.3
32899	Sept. 11	V. slight.	Slight.	0.34	7.45	2.60	.0100	.0326	.0292	.0034	.55	.0020	.0001	0.56	4.4
33244	Oct. 8	V. slight.	Slight.	0.43	8.75	2.95	.0080	.0234	.0200	.0034	.57	.0120	.0004	0.54	5.7
33371	Oct. 20	None.	V. slight.	0.78	10.20	3.50	.0028	.0308	.0302	.0006	.71	.0120	.0002	0.91	5.1
33640	Nov. 12	V. slight.	V. slight.	1.00	10.55	4.00	.0036	.0424	.0412	.0012	.69	.0110	.0001	1.20	5.7
34026	Dec. 11	None.	V. slight.	0.90	6.60	2.90	.0056	.0284	.0264	.0020	.67	.0090	.0001	1.27	2.1
Av.*.	....	....	....	0.64	7.26	2.69	.0055	.0306	.0278	.0028	.63	.0064	.0002	0.84	3.3

Odor, generally vegetable, sometimes musty or unpleasant, becoming stronger on heating.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

LYNN AND SAUGUS.

Chemical Examination of Water from the Saugus River at Howlett's Dam, Saugus.

[Parts per 100,000.]

		Appearance.			Residue on Evaporation.		Ammonia.					Nitrogen as			
								Albuminoid.							
Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
29890	Jan. 9	Decided.	V. slight.	0.32	11.05	3.00	.0902	.0276	.0244	.0032	1.54	.0400	.0012	0.52	4.2
30179	Feb. 13	Decided.	Cons.	0.62	5.45	2.05	.0120	.0326	.0284	.0042	0.48	.0220	.0004	0.81	1.3
30468	Mar. 13	V. slight.	Slight.	0.60	5.70	2.25	.0002	.0278	.0234	.0044	0.56	.0010	.0006	0.83	2.0
30956	Apr. 9	V. slight.	Cons.	0.68	5.70	2.35	.0040	.0288	.0268	.0020	0.54	.0060	.0001	0.84	2.3
31194	May 8	V. slight.	Slight.	1.15	8.30	3.05	.0080	.0328	.0304	.0024	1.11	.0420	.0013	1.07	3.1
31539	June 11	Slight.	Slight.	1.10	7.75	3.00	.0064	.0402	.0356	.0046	0.84	.0020	.0006	1.01	2.9
31986	July 10	V. slight.	Cons.	0.40	7.40	2.50	.0082	.0310	.0264	.0046	0.81	.0010	.0001	0.58	3.4
32496	Aug. 14	Slight.	V. slight.	0.34	8.20	2.20	.0182	.0272	.0252	.0020	1.15	.0130	.0017	0.52	4.3
32897	Sept. 11	Slight.	Slight.	0.44	9.35	2.60	.0088	.0464	.0342	.0122	1.45	.0030	.0001	0.59	4.4
33243	Oct. 8	V. slight.	Cons.	0.42	10.95	3.45	.0100	.0366	.0288	.0078	1.43	.0030	.0005	0.64	5.7
33638	Nov. 12	Decided.	Slight.	0.46	12.55	3.50	.0524	.0368	.0328	.0040	2.03	.0540	.0028	0.70	5.1
34024	Dec. 11	Slight.	V. slight.	1.05	9.75	3.90	.0120	.0364	.0322	.0042	0.89	.0920	.0007	1.29	4.0
Av...	....	....	....	0.63	8.51	2.82	.0192	.0336	.0290	.0046	1.07	.0232	.0008	0.78	3.6

Odor, vegetable or unpleasant, occasionally musty, becoming stronger on heating. Water from this source was not used for the supply of the city during 1900.

Chemical Examination of Water from a Faucet in Lynn supplied from the Lynn Water Works.

[Parts per 100,000.]

		Appearance.			Residue on Evaporation.		Ammonia.					Nitrogen as			
								Albuminoid.							
Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
29893	Jan. 9	V. slight.	V. slight.	.49	7.70	2.65	.0056	.0254	.0246	.0008	.68	.0140	.0001	.76	3.3
30182	Feb. 13	Slight.	V. slight.	.46	5.65	2.15	.0020	.0228	.0220	.0008	.53	.0120	.0002	.72	1.7
30471	Mar. 13	V. slight.	None.	.33	3.70	1.55	.0028	.0140	.0130	.0010	.47	.0030	.0001	.48	1.0
30959	Apr. 9	Slight.	Slight.	.24	3.10	1.40	.0024	.0154	.0130	.0024	.40	.0030	.0001	.42	0.6
31197	May 8	V. slight.	V. slight.	.28	3.20	1.00	.0012	.0174	.0156	.0018	.42	.0010	.0001	.46	1.0
31717	June 16	Slight.	Slight.	.32	3.25	1.35	.0032	.0188	.0182	.0006	.39	.0030	.0000	.47	0.8
31989	July 10	V. slight.	V. slight.	.24	4.00	1.50	.0022	.0196	.0176	.0020	.43	.0010	.0002	.39	1.1
32499	Aug. 14	V. slight.	V. slight.	.35	3.15	1.25	.0016	.0198	.0182	.0016	.46	.0020	.0000	.44	1.4
32891	Sept. 11	V. slight.	V. slight.	.26	4.05	1.45	.0002	.0200	.0192	.0008	.49	.0020	.0001	.43	1.4
33246	Oct. 8	V. slight.	Slight.	.35	3.05	1.15	.0044	.0222	.0204	.0018	.46	.0010	.0001	.49	0.8
33641	Nov. 12	Slight.	V. slight.	.34	3.25	1.50	.0040	.0364	.0254	.0110	.44	.0010	.0000	.51	0.5
34027	Dec. 11	Slight.	Cons.	.25	3.50	1.25	.0048	.0208	.0166	.0042	.48	.0030	.0001	.44	1.1

Averages by Years.

-	1894	-	-	.76	4.60	1.95	.0023	.0216	.0194	.0022	.57	.0065	.0001	.62	1.3
-	1895	-	-	.78	5.12	2.14	.0017	.0225	.0195	.0030	.65	.0102	.0001	.84	1.7
-	1896	-	-	.54	4.41	1.79	.0015	.0217	.0179	.0038	.51	.0063	.0001	.58	1.3
-	1897	-	-	.53	4.88	1.75	.0012	.0206	.0179	.0027	.59	.0079	.0001	.51	1.8
-	1898	-	-	.45	3.75	1.55	.0007	.0173	.0159	.0014	.46	.0047	.0000	.46	1.1
-	1899	-	-	.30	3.55	1.45	.0025	.0181	.0157	.0024	.42	.0069	.0001	.42	0.9
-	1900	-	-	.33	3.97	1.52	.0029	.0210	.0186	.0024	.47	.0038	.0001	.50	1.2

NOTE to analyses of 1900: Odor of No. 33641, unpleasant; of the others, vegetable, or none.

Water Supply of Malden.

(See *Metropolitan Water District*, pages 109–128.)

Water Supply of Manchester.

Chemical Examination of Water from the Large Well of the Manchester Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30132	Feb. 6	None.	V. slight.	.00	11.20	.0000	.0008	2.12	.1560	.0000	.02	3.9	.0100
31148	May 2	None.	V. slight.	.00	11.40	.0000	.0002	2.10	.1520	.0000	.00	3.6	.0020
31513	June 11	None.	None.	.00	10.00	.0000	.0006	1.57	.1280	.0001	.02	3.3	.0050
32369	Aug. 6	None.	None.	.00	10.00	.0000	.0004	1.51	.1440	.0000	.02	3.0	.0030
33341	Oct. 18	None.	None.	.00	10.30	.0000	.0004	1.78	.1640	.0000	.01	3.1	.0050
34153	Dec. 17	None.	None.	.00	11.40	.0000	.0010	2.10	.1500	.0000	.01	3.6	.0080

Averages by Years.

-	1892	-	-	.00	9.38	.0001	.0003	1.75	.1214	.0001	-	3.4	-
-	1893	-	-	.00	9.64	.0000	.0002	1.69	.0975	.0000	.04	3.5	.0096
-	1894	-	-	.00	9.82	.0000	.0006	1.82	.0700	.0000	.01	3.4	.0010
-	1895	-	-	.01	9.87	.0001	.0005	1.80	.0737	.0000	.02	3.3	.0040
-	1896	-	-	.00	10.67	.0003	.0004	1.94	.0950	.0000	.01	3.4	.0027
-	1897	-	-	.01	11.00	.0004	.0014	1.98	.1045	.0000	.00	3.9	.0017
-	1898	-	-	.01	10.87	.0002	.0007	1.91	.1298	.0000	.01	3.6	.0023
-	1899	-	-	.00	10.38	.0000	.0009	1.69	.1736	.0000	.03	3.1	.0020
-	1900	-	-	.00	10.72	.0000	.0006	1.86	.1490	.0000	.01	3.4	.0055

Note to analyses of 1900: Odor, none.

Chemical Examination of Water from Gravel Pond, Manchester.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
33103	Sept. 26	V. slight.	None.	.09	3.60	1.00	.0000	.0126	.0120	.0006	.83	.0020	.0000	.20	0.3

Odor, very faintly unpleasant. —— The sample was collected from the shore of the pond, near its outlet. This pond is not used as a source of water supply.

MANSFIELD WATER SUPPLY DISTRICT.

Water Supply of Mansfield Water Supply District, Mansfield.

Chemical Examination of Water from the Well of the Mansfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
31923	1900. July 2	None.	None.	.00	2.70	.0000	.0000	.25	.0020	.0000	.00	0.3	.0020

Odor, none. —— The sample was collected from a faucet at the pumping station.

Mansfield.

The advice of the State Board of Health to the board of health of Mansfield, relative to the use of Rumford River as a source of ice supply, may be found on page 97 of this volume. The results of analyses of samples of water collected from this stream are given in the following table: —

Chemical Examination of Water from Rumford River, Mansfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
33286	1900. Oct. 12	Slight.	Slight.	.31	4.65	1.15	.0028	.0132	.0120	.0012	.56	.0050	.0002	.34	1.3
33287	Oct. 12	Slight.	Slight.	.33	4.65	1.15	.0028	.0148	.0140	.0008	.63	.0090	.0001	.37	1.6

Odor, none, becoming distinctly vegetable on heating. —— The first sample was collected from the river, just below Cobb's jewelry factory; the last, from the river, at the outlet of Fisher's Pond.

Water Supply of Marblehead.

Chemical Examination of Water from Collecting Well No. 1 of the Marblehead Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
29817	1899. Dec. 30	Decided.	Heavy.	.13	19.10	.0210	.0032	3.01	.0180	.0002	.09	8.1	.1500
30120	1900. Feb. 5	Decided.	Cons.	.01	17.20	.0232	.0040	2.27	.0120	.0003	.08	6.4	.3300
30379	Mar. 5	Decided.	Cons.	.10	17.80	.0158	.0030	2.70	.0300	.0003	.06	7.3	.1580
30885	Mar. 30	Decided.	Cons.	.05	15.80	.0206	.0032	2.05	.0060	.0001	.08	6.3	.4200
33549	Nov. 2	V. slight.	V. slight.	.01	14.10	.0002	.0046	1.72	.0090	.0000	.01	5.7	.0170
33922	Dec. 4	Decided.	Cons.	.45	16.00	.0152	.0030	2.44	.0320	.0000	.03	5.7	.2300
Av...	....	....	....	.12	16.67	.0160	.0035	2.36	.0178	.0001	.06	6.6	.2175

Odor, none. —— The samples represent a mixture of water from collecting well No. 1 with water from collecting well No. 2, which flows into it.

Chemical Examination of Water from Collecting Well No. 2 of the Marblehead Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
29818	1899. Dec. 30	Decided.	Heavy.	.07	16.20	.0250	.0040	1.78	.0010	.0001	.10	6.4	.1700
30121	1900. Feb. 5	Decided.	Cons.	.00	17.40	.0258	.0038	1.63	.0010	.0001	.08	6.4	.4400
30380	Mar. 5	Decided.	Cons.	.06	18.20	.0286	.0038	1.85	.0010	.0001	.09	7.4	.4800
30886	Mar. 30	Decided.	Cons.	.02	17.40	.0266	.0038	1.85	.0050	.0000	.10	6.3	.4000
33550	Nov. 2	Decided.	Cons.	.02	16.00	.0190	.0054	2.26	.0320	.0002	.02	5.3	.1500
33923	Dec. 4	Decided.	Heavy.	.80	15.80	.0266	.0032	1.75	.0020	.0001	.07	5.7	.3600
Av...	....	....	....	.16	16.83	.0253	.0040	1.85	.0070	.0001	.08	6.2	.3333

Odor, none.

MARION.

Marion.

The advice of the State Board of Health to Edgar Welch and others, relative to a proposed water supply for the towns of Marion, Wareham and Mattapoisett, may be found on page 48 of this volume. The results of analyses of samples of water from the proposed sources of supply are given under "Wareham."

Water Supply of Marlborough.

Chemical Examination of Water from Lake Williams, Marlborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29881	Jan. 8	Slight.	Slight.	.10	4.55	1.30	.0000	.0250	.0212	.0038	.57	.0020	.0001	.29	1.7
30976	Apr. 10	Decided.	Slight.	.12	3.75	1.15	.0000	.0200	.0180	.0020	.41	.0010	.0000	.29	1.4
32000	July 11	V. slight.	Slight.	.09	4.05	1.00	.0006	.0264	.0206	.0058	.38	.0020	.0000	.27	1.8
33232	Oct. 8	Slight.	Slight.	.10	4.50	1.00	.0026	.0260	.0212	.0048	.49	.0030	.0002	.28	1.7
Av...	....	....	....	.10	4.21	1.11	.0008	.0243	.0202	.0041	.46	.0020	.0001	.28	1.6

Odor of No. 30976, none, becoming distinctly unpleasant and fishy on heating; of the others, vegetable. —— The last sample was collected from the lake; the others, from a faucet at the pumping station.

Chemical Examination of Water from the North Branch of Millham Brook, near its Entrance to the Millham Brook Storage Reservoir, Marlborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29877	Jan. 8	V. slight.	V. slight	1.10	7.75	2.60	.0098	.0244	.0230	.0014	.40	.0040	.0001	0.94	2.2
30166	Feb. 12	Slight.	Slight.	0.75	4.80	1.95	.0034	.0220	.0188	.0032	.22	.0060	.0002	0.90	0.8
30454	Mar. 13	V. slight.	V. slight.	0.67	4.40	1.60	.0010	.0184	.0176	.0008	.26	.0050	.0000	0.72	1.3
30972	Apr. 10	V. slight.	V. slight	0.72	4.05	1.65	.0000	.0186	.0182	.0004	.28	.0010	.0000	0.80	0.8
31179	May 7	V. slight.	V. slight.	1.50	5.05	2.15	.0004	.0266	.0256	.0010	.26	.0000	.0000	0.84	1.1
31522	June 11	Decided.	Slight.	2.20	5.85	3.00	.0020	.0348	.0324	.0024	.24	.0020	.0001	1.51	1.1
32478	Aug. 14	Slight.	V. slight.	0.56	4.25	1.30	.0006	.0250	.0236	.0014	.29	.0000	.0000	0.66	0.8
33231	Oct. 8	V. slight.	Cons.	0.31	4.30	1.20	.0026	.0210	.0150	.0060	.32	.0010	.0000	0.37	1.1
33623	Nov. 12	None.	V slight.	1.00	8.35	3.30	.0080	.0348	.0310	.0038	.54	.0040	.0000	1.57	2.1
34003	Dec. 10	None.	V. slight.	1.05	7.20	3.05	.0030	.0252	.0226	.0026	.47	.0300	.0001	1.01	2.2

MARLBOROUGH.

Chemical Examination of Water from the North Branch of Millham Brook, near its Entrance to the Millham Brook Storage Reservoir, Marlborough — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
-	1896	-	-	1.22	5.45	2.11	.0023	.0262	.0226	.0036	.35	.0095	.0001	1.09	1.4
-	1897	-	-	1.46	5.65	2.51	.0022	.0291	.0265	.0026	.38	.0076	.0001	1.05	1.4
-	1898	-	-	1.35	5.44	2.53	.0018	.0265	.0236	.0029	.34	.0107	.0001	1.05	1.3
-	1899	-	-	0.84	4.82	1.93	.0038	.0287	.0234	.0053	.29	.0100	.0001	0.78	1.1
-	1900	-	-	0.99	5.60	2.18	.0031	.0251	.0228	.0023	.33	.0053	.0000	0.93	1.3

NOTE to analyses of 1900: Odor, generally vegetable, occasionally unpleasant. A fishy odor was developed in No. 33231, and an oily odor in No. 33623, on heating.

Chemical Examination of Water from Millham Brook, near its Entrance to the Millham Brook Storage Reservoir, Marlborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29878	Jan. 8	V. slight.	V. slight.	0.30	6.95	2.85	.0044	.0204	.0178	.0026	.44	.0050	.0001	0.57	2.0
30167	Feb. 12	Slight.	V. slight.	0.49	5.05	1.80	.0006	.0190	.0178	.0012	.32	.0120	.0002	0.64	2.0
30451	Mar. 13	V. slight.	V. slight.	0.33	4.25	1.50	.0008	.0126	.0116	.0010	.38	.0200	.0000	0.43	1.4
30973	Apr. 10	V. slight	None.	0.33	3.85	1.10	.0000	.0156	.0148	.0008	.33	.0060	.0001	0.48	1.3
31176	May 7	V. slight.	V. slight.	0.59	4.70	1.80	.0008	.0194	.0186	.0008	.32	.0110	.0001	0.70	1.4
31523	June 11	V. slight	Slight.	1.10	5.85	2.50	.0060	.0276	.0260	.0016	.34	.0100	.0002	1.02	2.1
31997	July 11	None.	Slight.	0.11	4.25	1.05	.0016	.0132	.0110	.0022	.33	.0060	.0001	0.23	2.1
32479	Aug. 14	V. slight.	V. slight.	0.30	4.65	1.25	.0004	.0200	.0172	.0028	.39	.0040	.0001	0.47	1.8
33228	Oct. 8	None.	Slight.	0.46	7.40	2.40	.0040	.0192	.0180	.0012	.47	.0010	.0000	0.62	2.3
33624	Nov. 12	None.	V. slight.	0.62	7.80	2.50	.0056	.0300	.0286	.0014	.49	.0300	.0000	1.15	2.6
34002	Dec. 10	None.	V. slight.	0.58	6.75	2.85	.0056	.0210	.0196	.0014	.45	.0450	.0002	0.79	2.4

Averages by Years.

-	1896	-	-	0.62	5.47	1.90	.0022	.0199	.0174	.0025	.37	.0209	.0001	0.65	1.9
-	1897	-	-	0.74	5.27	2.02	.0018	.0214	.0198	.0016	.38	.0162	.0001	0.65	2.0
-	1898	-	-	0.54	5.12	2.11	.0016	.0172	.0156	.0016	.39	.0165	.0001	0.53	1.8
-	1899	-	-	0.29	4.97	1.65	.0021	.0169	.0149	.0020	.39	.0128	.0001	0.40	1.8
-	1900	-	-	0.47	5.59	1.96	.0027	.0198	.0183	.0015	.39	.0136	.0001	0.65	1.9

NOTE to analyses of 1900: Odor, generally vegetable, occasionally none.

MARLBOROUGH.

Chemical Examination of Water from Millham Brook Storage Reservoir, Marlborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
29879	Jan. 8	V. slight.	Slight.	.37	4.50	1.85	.0010	.0358	.0314	.0044	.32	.0040	.0001	.53	1.7
30168	Feb. 12	Decided.	Cons	.47	4.00	1.70	.0000	.0436	.0258	.0178	.19	.0080	.0001	.71	0.5
30452	Mar. 13	Decided.	Slight.	.36	3.60	1.30	.0006	.0184	.0170	.0014	.25	.0050	.0001	.44	0.8
30974	Apr. 10	Decided.	Cons.	.25	2.80	1.00	.0002	.0232	.0156	.0076	.23	.0010	.0000	.40	0.5
31177	May 7	Slight.	Cons.	.34	3.60	1.20	.0004	.0276	.0184	.0092	.23	.0000	.0000	.51	1.0
31524	June 11	Slight.	Cons.	.50	3.50	1.50	.0012	.0336	.0240	.0096	.28	.0020	.0000	.62	1.0
31998	July 11	Slight.	Cons.	.40	3.45	1.10	.0058	.0338	.0254	.0084	.22	.0010	.0001	.53	1.1
32480	Aug. 14	Slight.	Cons.	.40	3.70	1.40	.0004	.0364	.0260	.0104	.26	.0010	.0000	.53	1.0
32855	Sept. 10	Slight.	Cons	.31	3.85	1.35	.0004	.0324	.0246	.0078	.28	.0030	.0000	.48	0.8
33229	Oct. 8	V. slight.	Cons	.59	4.15	1.30	.0084	.0436	.0274	.0162	.29	.0020	.0000	.60	1.4
33625	Nov. 12	Slight.	Slight.	.42	4.00	1.60	.0112	.0384	.0284	.0100	.30	.0010	.0001	.49	1.1
34004	Dec. 10	V. slight.	Cons.	.50	4.25	1.50	.0050	.0310	.0236	.0074	.26	.0110	.0002	.65	1.8

Averages by Years.

-	1896	-	-	.80	4.44	1.68	.0058	.0306	.0248	.0058	.30	.0088	.0003	.69	1.3
-	1897	-	-	.83	4.24	1.77	.0031	.0293	.0243	.0050	.30	.0088	.0001	.64	1.5
-	1898	-	-	.67	4.30	1.95	.0050	.0239	.0191	.0048	.32	.0095	.0001	.59	1.3
-	1899	-	-	.37	3.67	1.58	.0065	.0323	.0223	.0100	.27	.0081	.0001	.43	1.1
-	1900	-	-	.41	3.78	1.40	.0029	.0332	.0240	.0092	.26	.0032	.0001	.54	1.1

NOTE to analyses of 1900: Odor, generally vegetable or unpleasant.—— The samples were collected from the reservoir, 2 feet beneath the surface.

Microscopical Examination of Water from Millham Brook Storage Reservoir, Marlborough.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	9	13	14	12	8	12	12	15	11	9	13	12
Number of sample,	29879	30168	30452	30974	31177	31524	31998	32480	32855	33229	33625	34004
PLANTS.												
Diatomaceæ,	**2,122**	**372**	**30**	**212**	**116**	**5,188**	**64**	**21**	**77**	**372**	**846**	**1,356**
Asterionella,	2,120	372	30	210	90	280	0	0	7	232	178	582
Cyclotella,	0	0	0	0	6	196	39	3	5	2	60	46
Fragilaria,	0	0	0	0	16	788	23	10	23	82	28	36
Tabellaria,	1	0	0	0	0	3,920	2	8	40	56	580	666
Cyanophyceæ,	**0**	**2**	**0**	**0**	**10**	**120**	**129**	**114**	**236**	**68**	**150**	**46**
Anabæna,	0	0	0	0	0	120	73	1	125	24	130	46
Cœlosphærium,	0	2	0	0	8	0	56	110	102	44	20	0
Algæ,	**8**	**2**	**0**	**24**	**36**	**184**	**45**	**12**	**105**	**4**	**218**	**52**
Protococcus,	8	0	0	24	34	136	45	12	76	0	174	46

MARLBOROUGH.

Microscopical Examination of Water from Millham Brook Storage Reservoir, Marlborough — Concluded.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.												
Infusoria,	28	218	1	100	244	4	8	6	4	2	68	20
Chlamydomonas,	0	144	0	0	0	0	0	0	0	0	0	0
Dinobryon,	18	60	0	8	244	0	0	0	0	0	56	10
Euglena,	2	10	0	82	0	0	0	2	0	2	0	0
Peridinium,	2	2	0	10	0	0	0	0	1	0	0	0
Vermes,	4	0	0	0	0	0	0	0	1	0	0	0
Crustacea,	0	pr.	0	pr.	pr.	0	pr.	0	0	pr.	pr.	pr.
Bosmina,	0	0	0	0	0	0	pr.	0	0	0	0	0
Cyclops,	0	pr.	0	pr.	pr.	0	pr.	0	0	pr.	pr.	pr.
Miscellaneous, Zoöglœa,	3	14	10	50	6	10	10	3	7	5	10	5
TOTAL,	2,165	608	41	386	412	5,506	256	156	430	451	1,292	1,479

Chemical Examination of Water from Millham Brook Storage Reservoir, Marlborough, collected near the Bottom.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness
	1900.														
29880	Jan. 8	Slight.	Cons.	0.34	4.35	1.75	.0054	.0350	.0278	.0072	.30	.0040	.0001	0.52	1.4
30169	Feb 12	Decided.	Cons.	0.50	4.45	1.75	.0200	.0366	.0278	.0088	.27	.0060	.0001	0.54	1.3
30453	Mar. 13	Decided.	Cons.	0.46	3.40	1.30	.0072	.0204	.0174	.0030	.24	.0020	.0002	0.48	0.6
30975	Apr. 10	Decided.	Cons.	0.25	2.60	0.95	.0004	.0254	.0166	.0088	.23	.0010	.0000	0.40	0.3
31178	May. 7	Slight.	Slight.	0.37	3.75	1.25	.0006	.0272	.0184	.0088	.24	.0010	.0000	0.53	0.8
31525	June 11	Decided.	Cons.	2.00	5.30	2.40	.0840	.0380	.0304	.0076	.27	.0010	.0001	1.09	1.1
31999	July 11	Decided.	Cons.	1.36	4.55	1.45	.0776	.0476	.0276	.0200	.23	.0010	.0001	0.70	1.1
32481	Aug. 14	Decided.	Cons.	2.64	6.25	2.00	.4700	.0610	.0280	.0330	.26	.0010	.0000	0.98	1.4
32856	Sept. 10	Decided.	Heavy.	1.50	5.30	1.70	.1360	.0575	.0275	.0300	.25	.0020	.0002	0.66	1.6
33230	Oct. 8	Decided.	Heavy.	0.82	4.45	1.50	.0624	.0532	.0292	.0240	.28	.0020	.0000	0.52	1.4
33626	Nov 12	Slight.	Slight.	0.42	4.00	1.50	.0136	.0396	.0272	.0124	.29	.0020	.0001	0.45	1.0
34005	Dec. 10	V.slight.	Cons.	0.43	4.80	1.75	.0056	.0322	.0246	.0076	.28	.0080	.0001	0.64	1.7

Averages by Years.

–	1896	–	–	1.04	5.07	1.94	.0185	.0331	.0271	.0060	.31	.0110	.0002	0.82	1.5
–	1897	–	–	1.47	5.33	2.24	.0233	.0343	.0288	.0055	.32	.0075	.0003	0.79	1.7
–	1898	–	–	1.29	5.21	2.35	.0472	.0285	.0224	.0061	.31	.0071	.0002	0.68	1.5
–	1899	–	–	0.80	4.25	1.62	.0310	.0370	.0238	.0132	.29	.0086	.0001	0.49	1.3
–	1900	–	–	0.92	4.43	1.61	.0402	.0395	.0252	.0143	.26	.0026	.0001	0.63	1.1

NOTE to analyses of 1900: Odor, generally unpleasant, occasionally vegetable. —— The samples were collected from the reservoir, 2 feet above the bottom.

MARSHFIELD.

Water Supply of Brant Rock, Marshfield. — Brant Rock Water Company.

Chemical Examination of Water from the Well of the Brant Rock Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
32403	1900. Aug. 7	None.	None.	.00	12.20	.0000	.0006	3.36	.1300	.0000	.03	2.3	.0050

Odor, none. — The sample was collected from a faucet at the pumping station.

Mattapoisett.

The advice of the State Board of Health to Edgar Welch and others, relative to a proposed water supply for the towns of Mattapoisett, Marion and Wareham, may be found on page 48 of this volume. The results of analyses of samples of water from the proposed sources of supply are given under "Wareham."

Water Supply of Maynard.

Chemical Examination of Water from White Pond, Maynard.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
30636	1900. Mar. 20	None.	V. slight.	.02	1.55	0.50	.0012	.0112	.0102	.0010	.29	.0010	.0000	.11	0.2
31771	June 19	V. slight.	Cons.	.02	2.15	0.80	.0008	.0190	.0174	.0016	.37	.0010	.0000	.16	0.2
33052	Sept. 24	V. slight.	Slight.	.02	2.50	0.85	.0004	.0164	.0128	.0036	.37	.0030	.0000	.13	0.2
34126	Dec. 18	V. slight.	V. slight.	.06	2.85	0.75	.0012	.0124	.0102	.0022	.33	.0010	.0000	.28	1.0
Av...	....	....	....	.03	2.26	0.72	.0009	.0147	.0126	.0021	.34	.0015	.0000	.17	0.4

Odor of the second sample, none, becoming very faintly vegetable on heating; of the others, none. — No. 34126 was collected from a faucet in the town; the others, from the pond.

Medfield.

Chemical Examination of Water from a Spring in Medfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
32825	1900. Sept. 5	None.	None.	.00	2.90	.0004	.0020	.26	.0020	.0000	.03	0.6	.0040

Odor, none. —— The sample was collected from a spring near Vine Brook about one-third of a mile above North Street. This spring is used as a source of water supply by a large straw factory and by a portion of the village of Medfield.

Water Supply of Medfield Insane Asylum.

Chemical Examination of Water from Farm Pond in Sherborn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30725	Mar. 26	V. slight.	V. slight.	.06	1.70	0.60	.0012	.0122	.0116	.0006	.24	.0020	.0003	.12	0.0
31861	June 27	V. slight.	V. slight.	.01	2.20	1.25	.0008	.0124	.0118	.0006	.24	.0010	.0000	.12	0.0
33065	Sept. 25	V. slight.	V. slight.	.06	1.70	0.50	.0010	.0120	.0116	.0004	.25	.0020	.0000	.09	0.0
34196	Dec. 21	V. slight.	Slight.	.02	1.60	0.80	.0020	.0190	.0142	.0048	.25	.0070	.0001	.15	0.0
Av...	....	....	....	.04	1.80	0.79	.0012	.0139	.0123	.0016	.24	.0030	.0001	.12	0.0

Odor of the first two samples, very faintly vegetable; of the third, none, becoming faintly unpleasant on heating; of the last, distinctly disagreeable and fishy. —— The samples were collected from a faucet at the asylum supplied from the pond.

Water Supply of Medford.

(See *Metropolitan Water District*, pages 109–128.)

Medford. — Tufts College.

The advice of the State Board of Health to the president of Tufts College, relative to the use of the water of a well on the college

MEDFORD.

grounds for drinking purposes, may be found on page 48 of this volume. The results of an analysis of a sample of water collected from the well are given in the following table: —

Chemical Examination of Water from a Well at Tufts College, Medford.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
33076	1900. Sept. 25	None.	None.	.00	10.30	.0010	.0022	.74	.1040	.0001	.01	3.3	.0020

Odor, faintly unpleasant, becoming stronger on heating. —— The sample was collected from a well situated near the library of Tufts College.

Water Supply of Melrose.

(See *Metropolitan Water District*, pages 109–128.)

Melrose.

The advice of the State Board of Health to the board of health of Melrose, relative to the use of Ell Pond in that town as a source of ice supply, may be found on page 97 of this volume. The results of an analysis of a sample of water collected from the pond are given in the following table: —

Chemical Examination of Water from Ell Pond, Melrose.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
30063	1900. Jan. 30	Decided.	Cons.	.40	8.25	2.60	.0166	.0312	.0226	.0086	.87	.0690	.0006	.53	2.6

Odor, none, becoming faintly cucumber on heating. —— The sample was collected from the pond, near its outlet.

WATER SUPPLY OF METHUEN.

Chemical Examination of Water from the Tubular Wells of the Methuen Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1900.												
30331	Feb. 27	V. slight.	None.	.08	6.10	.0004	.0058	.30	.0200	.0000	.14	2.7	.0100
31088	Apr. 24	V. slight.	V. slight.	.02	6.80	.0010	.0034	.35	.0240	.0000	.08	2.9	.0120
31885	June 26	None.	None.	.02	6.40	.0000	.0042	.34	.0300	.0000	.12	3.3	.0060
32713	Aug. 29	None.	V. slight.	.01	7.30	.0000	.0030	.38	.0320	.0000	.06	3.0	.0080
33483	Oct. 29	V. slight.	V. slight.	.12	9.30	.0000	.0050	.34	.0210	.0000	.10	3.9	.0530
34163	Dec. 19	Decided.	None.	.22	9.00	.0004	.0062	.34	.0050	.0001	.04	3.9	.0450
Av...	....	....	....	.08	7.48	.0003	.0046	.34	.0220	.0000	.09	3.3	.0223

Odor, none. —— The first and last samples were collected from a faucet in the town; the others, from the wells.

WATER SUPPLY OF MIDDLEBOROUGH FIRE DISTRICT, MIDDLEBOROUGH.

Chemical Examination of Water from the Well of the Middleborough Fire District.

[Parts per 100,000.]

Number.	Date of Collection	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1900.												
29851	Jan. 3	None.	V. slight.	.05	6.00	.0014	.0022	.68	.0600	.0000	.06	2.6	.0330
30118	Feb. 6	None.	V. slight.	.03	6.10	.0014	.0022	.70	.0750	.0000	.07	2.3	.0490
30381	Mar. 6	V. slight.	V. slight.	.00	6.50	.0010	.0020	.77	.0920	.0000	.06	2.2	.0310
30920	Apr. 4	None.	V. slight.	.02	6.20	.0006	.0012	.74	.1080	.0000	.05	2.3	.0260
31146	May 2	V. slight.	V. slight.	.08	6.00	.0012	.0020	.69	.0860	.0000	.07	2.3	.0310
31477	June 6	V. slight.	Cons.	.12	7.00	.0012	.0048	.76	.0910	.0001	.14	2.9	.0410
31929	July 2	Decided.	Slight.	.22	5.30	.0012	.0062	.66	.0220	.0000	.13	2.1	.0500
32368	Aug. 6	Decided.	V. slight.	.28	6.10	.0000	.0064	.64	.0370	.0001	.21	2.1	.0600
32823	Sept 5	Decided.	V slight.	.28	5.30	.0002	.0048	.65	.0200	.0000	.11	1.6	.0540
33179	Oct. 3	Decided.	V. slight.	.25	5.40	.0006	.0042	.63	.0240	.0000	.11	2.0	.1150
33602	Nov. 7	Slight.	Cons.	.24	6.00	.0026	.0042	.66	.0430	.0001	.11	2.0	.0520
33949	Dec. 5	V. slight	Cons.	.19	6.00	.0036	.0046	.67	.0530	.0001	.11	2.2	.0450

Averages by Years.

-	1888	-	-	.00	8.67	.0001	.0025	.96	.1494	.0001	-	-	-
-	1895	-	-	.06	6.74	.0001	.0028	.74	.0687	.0000	.08	2.6	.0187
-	1896	-	-	.18	6.54	.0003	.0038	.72	.0565	.0000	.09	2.4	.0288
-	1897	-	-	.09	6.28	.0006	.0039	.71	.0580	.0000	.11	2.5	.0227
-	1898	-	-	.16	6.78	.0008	.0044	.75	.0687	.0001	.14	2.7	.0408
-	1899	-	-	.15	6.54	.0010	.0037	.69	.0684	.0000	.12	2.3	.0329
-	1900	-	-	.15	5.99	.0012	.0037	.69	.0592	.0000	.10	2.2	.0489

NOTE to analyses of 1900: Odor, none.

MIDDLETON.

Water Supply of Middleton.

(See *Danvers*.)

Water Supply of Milford and Hopedale. — Milford Water Company.

Chemical Examination of Water from the Wells of the Milford Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30241	Feb. 20	V. slight.	Slight.	.20	3.50	.0002	.0078	.24	.0050	.0000	.33	0.8	.0180
31015	Apr. 16	None.	None.	.20	2.80	.0010	.0090	.23	.0060	.0000	.35	0.8	.0080
31898	June 29	None.	V. slight.	.25	3.50	.0000	.0100	.21	.0060	.0001	.35	0.8	.0140
32589	Aug. 22	V. slight.	V. slight.	.09	3.80	.0000	.0074	.24	.0090	.0000	.23	0.6	.0180
33300	Oct. 15	None.	V. slight.	.05	3.90	.0004	.0060	.28	.0180	.0000	.14	1.1	.0130
34202	Dec. 24	None.	V. slight.	.07	4.50	.0004	.0068	.31	.0330	.0001	.23	1.4	.0060
Av...	....	....	....	.14	3.67	.0003	.0078	.25	.0128	.0000	.27	0.9	.0128

Odor of No. 32589, distinctly vegetable; of the others, none. A very faintly vegetable odor was developed in the first sample on heating. —— The samples were collected from a tap in the pumping station, and represent a mixture of water from the wells with water from the Charles River which has passed through the sand filters.

Chemical Examination of Water from the Charles River opposite the Wells of the Milford Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30240	Feb. 20	Slight.	V. slight.	.40	3.20	1.60	.0006	.0196	.0176	.0020	.22	.0000	.0001	.62	0.5
31014	Apr. 16	V. slight.	V. slight.	.38	2.75	1.35	.0008	.0152	.0150	.0002	.21	.0030	.0000	.56	0.5
31897	June 29	V. slight.	Cons.	.66	3.75	1.75	.0006	.0248	.0224	.0024	.20	.0010	.0001	.79	0.5
32588	Aug. 22	V. slight.	Slight.	.50	3.60	1.85	.0024	.0300	.0278	.0022	.24	.0020	.0000	.68	0.3
33298	Oct. 15	V. slight.	Slight.	.30	4.45	1.40	.0022	.0206	.0192	.0014	.31	.0060	.0000	.45	0.6
34200	Dec. 24	V. slight.	V. slight.	.36	3.85	1.50	.0024	.0150	.0132	.0018	.29	.0120	.0000	.56	0.8
Av...	....	....	....	.43	3.60	1.57	.0015	.0209	.0192	.0017	.24	.0040	.0000	.61	0.5

Odor of No. 33298, faintly unpleasant, becoming stronger on heating; of the others, none, becoming faintly vegetable on heating.

MILLBURY.

Water Supply of Millbury. — Millbury Water Company.

Chemical Examination of Water from the Well of the Millbury Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
32300	July 30	None.	None.	.01	9.20	.0002	.0022	.16	.0210	.0001	.05	4.3	.0020

Odor, none.

Water Supply of Millis.

Chemical Examination of Water from the Aqua Rex Spring, Millis.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
32391	Aug. 7	None.	None.	.00	7.60	.0002	.0026	.58	.1600	.0000	.03	2.6	.0040

Odor, none.

Water Supply of Milton. — Milton Water Company.

(See *Hyde Park.*)

Water Supply of Monson.

Chemical Examination of Water from a Faucet in Monson, supplied from the Monson Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30053	Jan. 29	None.	None.	.00	2.90	.0000	.0008	.12	.0050	.0000	.03	0.6	.0010
30896	Mar. 29	None.	None.	.00	3.00	.0004	.0006	.13	.0060	.0000	.05	0.5	.0020
31566	June 13	None.	None.	.00	3.30	.0000	.0006	.14	.0070	.0000	.01	0.6	.0010
32364	Aug. 3	None.	None.	.00	3.30	.0000	.0002	.12	.0100	.0000	.00	0.8	.0150
32997	Sept. 19	None.	V. slight.	.00	3.50	.0002	.0008	.13	.0090	.0000	.00	1.0	.0030
33841	Nov. 28	None.	V. slight.	.00	3.30	.0002	.0008	.13	.0100	.0000	.00	1.0	.0050
Av.	....	....	....	.00	3.22	.0001	.0006	.13	.0078	.0000	.01	0.7	.0045

Odor, none.

MONTAGUE.

Water Supply of Turner's Falls Fire District, Montague.

Chemical Examination of Water from Lake Pleasant, Montague.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
30134	Feb. 7	V. slight.	None.	.03	2.00	0.85	.0038	.0088	.0084	.0004	.13	.0010	.0001	.09	0.5
31172	May 7	None.	V. slight.	.02	2.20	0.55	.0008	.0062	.0052	.0010	.11	.0050	.0000	.12	0.3
32474	Aug. 14	V. slight.	None.	.01	1.90	0.70	.0002	.0072	.0066	.0006	.10	.0010	.0000	.09	0.3
33628	Nov. 12	V slight.	V slight.	.04	2.00	0.55	.0008	.0090	.0086	.0004	.13	.0000	.0000	.08	0.5
Av...	....	....	....	.02	2.02	0.66	.0014	.0078	.0072	.0006	.12	.0017	.0000	.09	0.4

Odor of the second sample, faintly unpleasant; of the others, none.

Water Supply of Nahant.

(See *Metropolitan Water District*, pages 109–128.)

Water Supply of Nantucket. — Wannacomet Water Company.

Chemical Examination of Water from Wannacomet Pond, Nantucket.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
30627	Mar. 18	V. slight.	Slight.	.01	6.30	1.55	.0000	.0114	.0104	.0010	2.43	.0010	.0000	.09	1.3
31793	June 19	V. slight	Cons.	.01	6.90	1.60	.0030	.0166	.0150	.0016	2.40	.0010	.0000	.16	1.8
32443	Aug. 9	Decided.	Heavy.	.23	8.50	2.25	.0005	.0765	.0296	.0469	2.53	.0000	.0000	.23	1.6
32462	Aug. 13	Decided.	Cons.	.31	7.65	1.95	.0015	.0900	.0340	.0560	2.53	.0000	.0000	.24	1.7
32531	Aug. 16	Decided.	Heavy.	.48	8.00	1.75	.0030	.0850	.0350	.0500	2.51	.0020	.0000	.25	2.0
32555	Aug. 20	Decided.	Heavy.	.62	7.90	2.05	.0010	.0910	.0350	.0560	2.51	.0010	.0000	.39	1.8
32624	Aug. 23	Decided.	Heavy.	.60	8.90	2.15	.0010	.1260	.0490	.0770	2.50	.0020	.0000	.35	1.8
32673	Aug. 27	Decided.	Heavy.	.45	8.75	2.50	.0070	.1540	.0490	.1050	2.45	.0020	.0001	.20	1.7
32744	Aug. 30	Decided.	Heavy.	.37	9.00	2.40	.0050	.1060	.0450	.0610	2.48	.0040	.0000	.38	1.6
32806	Sept. 3	Decided.	Heavy.	.35	8.45	2.15	.0050	.0910	.0372	.0538	2.49	.0030	.0000	.26	1.4
32841	Sept. 6	Decided.	Heavy.	.65	9.00	2.20	.0070	.0880	.0400	.0480	2.49	.0020	.0000	.33	1.6
32860	Sept 10	Decided.	Cons.	.57	8.50	1.95	.0160	.0460	.0340	.0120	2.50	.0020	.0002	.28	1.7
32919	Sept. 13	Decided.	Cons.	.42	8.50	2.00	.0255	.0555	.0300	.0255	2.55	.0040	.0000	.27	1.7
33027	Sept. 20	Slight.	Cons.	.23	8.15	1.65	.0272	.0368	.0232	.0136	2.42	.0040	.0002	.26	1.7
33452	Oct. 24	V. slight.	Cons.	.05	7.90	1.30	.0112	.0284	.0154	.0130	2.38	.0010	.0002	.08	1.3
34159	Dec. 18	None.	V. slight.	.00	7.55	1.50	.0022	.0170	.0142	.0028	2.44	.0050	.0000	.10	1.7
Av.*..	....	....	....	.16	7.59	1.68	.0059	.0402	.0213	.0189	2.44	.0021	.0000	.17	1.6

Odor of the first and last samples, none; of the others, generally distinctly disagreeable or unpleasant and occasionally offensive.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NANTUCKET.

Microscopical Examination of Water from Wannacomet Pond, Nantucket.

[Number of organisms per cubic centimeter.]

	1900.							
	Mar.	June.	Aug.	Aug.	Aug.	Aug.	Aug.	Aug.
Day of examination,	20	21	10	14	17	21	24	28
Number of sample,	30627	31793	32443	32462	32531	32555	32624	32673
PLANTS.								
Diatomaceæ,	387	25	0	0	0	0	0	0
Synedra,	370	21	0	0	0	0	0	0
Cyanophyceæ,	1	0	2,680	2,160	3,660	3,256	3,680	3,320
Anabæna,	0	0	2,680	2,160	3,660	3,256	3,680	3,320
Algæ,	1	0	0	0	0	16	0	4
Pandorina,	0	0	0	0	0	16	0	4
ANIMALS.								
Rhizopoda, Actinophrys,	0	0	0	0	4	4	0	0
Infusoria,	881	19	4	4	4	4	4	0
Ceratium,	0	4	0	4	0	4	4	0
Cryptomonas,	0	0	0	0	0	0	0	0
Dinobryon,	880	13	0	0	0	0	0	0
Trachelomonas,	0	2	0	0	4	0	0	0
Vermes,	0	0	0	4	4	0	0	0
Crustacea,	0	pr.	0	pr.	0	pr.	pr.	0
Cyclops,	0	pr.	0	pr.	0	pr.	pr.	0
Daphnia,	0	0	0	pr.	0	0	pr.	0
Miscellaneous, Zoöglœa,	3	5	20	12	20	28	20	12
TOTAL,	1,273	49	2,704	2,180	3,692	3,308	3,704	3,336

NANTUCKET.

Microscopical Examination of Water from Wannacomet Pond, Nantucket — Concluded.

[Number of organisms per cubic centimeter.]

	1900.							
	Aug.	Sept.	Sept.	Sept.	Sept.	Sept.	Oct.	Dec.
Day of examination,	31	6	8	11	14	22	26	20
Number of sample,	32744	32806	32841	32860	32919	33027	33452	34159
PLANTS.								
Diatomaceæ,	0	0	0	0	0	0	20	5
Synedra,	0	0	0	0	0	0	15	5
Cyanophyceæ, Anabæna,	3,136	1,188	1,272	118	12	0	0	0
Algæ,	0	20	24	14	177	10	3	2
Pandorina,	0	20	24	14	152	9	0	0
ANIMALS.								
Infusoria,	0	246	34	70	258	331	146	0
Ceratium,	0	0	0	16	10	7	0	0
Cryptomonas,	0	0	0	0	25	0	0	0
Dinobryon,	0	0	0	0	0	0	39	0
Trachelomonas,	0	246	33	54	221	322	104	0
Vermes,	4	2	0	0	7	15	0	0
Crustacea,	0	pr.	0	0	pr.	0	pr.	0
Cyclops,	0	pr.	0	0	pr.	0	pr.	0
Daphnia,	0	0	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	12	40	8	12	10	10	5	5
TOTAL,	3,152	1,496	1,338	214	464	366	174	12

NANTUCKET.

Chemical Examination of Water from Wannacomet Pond, after Filtration.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
32444	Aug. 9	V. slight.	V. slight.	.06	7.80	–	.0100	.0260	.0204	.0056	2.53	.0000	.0002	.19	1.7
32445	Aug. 9	Slight.	V. slight.	.19	8.50	–	.0116	.0330	.0226	.0104	2.54	.0000	.0009	.26	1.7
32446	Aug. 9	Decided.	Slight.	.20	8.20	–	.0106	.0316	.0220	.0096	2.55	.0000	.0010	.25	1.8
32463	Aug. 13	Decided.	Cons.	.19	12.50	–	.1880	.1190	.0580	.0610	2.54	.0010	.0000	.73	3.0
32532	Aug. 16	Decided.	Cons.	.43	9.10	–	.0050	.0660	.0350	.0310	2.52	.0000	.0001	.35	2.0
32556	Aug. 20	Slight.	V. slight.	.11	8.20	–	.0024	.0266	.0204	.0062	2.56	.0020	.0002	.18	2.1
32557	Aug. 20	Slight.	V slight.	.15	8.50	–	.0042	.0260	.0212	.0048	2.56	.0020	.0003	.21	2.1
32558	Aug. 20	Slight.	Slight.	.21	8.00	–	.0040	.0276	.0212	.0064	2.57	.0040	.0003	.22	2.0
32625	Aug. 23	Slight.	Slight.	.09	8.30	–	.0134	.0278	.0200	.0078	2.56	.0010	.0001	.19	2.0
32626	Aug. 23	Decided.	Cons.	.04	10.20	–	.0212	.0480	.0252	.0228	2.55	.0010	.0000	.31	2.1
32627	Aug. 23	Decided.	Cons.	.08	10.70	–	.0224	.0408	.0232	.0176	2.56	.0010	.0000	.31	2.1
32674	Aug. 27	Slight.	V. slight.	.26	7.70	–	.0420	.0365	.0280	.0085	2.50	.0020	.0006	.27	1.8
32675	Aug. 27	Decided.	Cons.	–	8.90	–	.0700	.0480	.0280	.0200	2.51	.0030	.0000	.50	2.1
32676	Aug. 27	Decided.	Cons.	–	9.60	–	.0630	.0460	.0270	.0190	2.49	.0030	.0000	.49	2.0
32745	Aug 30	Decided.	Cons.	.35	8.50	2.50	.0140	.1020	.0480	.0540	2.44	.0060	.0000	.35	1.4
32807	Sept. 3	None.	Slight.	.00	7.30	–	.0000	.0036	–	–	2.32	.0130	.0000	.03	0.8
32842	Sept. 6	Decided.	V. slight.	.33	8.40	–	.0020	.0392	.0308	.0084	2.53	.0050	.0000	.23	1.4
32861	Sept. 10	Slight.	V. slight	.13	7.80	–	.0034	.0174	–	–	2.54	.0070	.0004	.10	1.7
32920	Sept. 13	Decided.	Slight.	.58	8.00	–	.0420	.0216	–	–	2.60	.0020	.0007	.13	2.0
32921	Sept. 13	Slight.	Slight.	.32	9.10	–	.0404	.0180	–	–	2.56	.0050	.0017	.14	1.8
33028	Sept. 20	Slight.	Slight.	.38	8.00	–	.0264	.0336	–	–	2.44	.0060	.0007	.25	1.7
33029	Sept. 20	V. slight.	V. slight.	.20	9.00	–	.0028	.0192	–	–	2.43	.0120	.0020	.15	2.1
Av.*.	....	....	....	.23	8.60	–	.0244	.0344	–	–	2.51	.0044	.0005	.23	1.8

Odor of Nos. 32807 and 32842, none; of the others, generally distinctly disagreeable or unpleasant and occasionally offensive.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NANTUCKET.

Microscopical Examination of Water from Wannacomet Pond, after Filtration.

[Number of organisms per cubic centimeter.]

	1900.										
	Aug.	Aug.	Aug.	Aug.	Aug.	Aug.	Aug.	Aug.	Aug.	Aug.	Aug.
Day of examination,	10	10	10	14	17	21	21	21	24	24	24
Number of sample,	32444	32445	32446	32463	32532	32556	32557	32558	32625	32626	32627
PLANTS.											
Diatomaceæ,	0	0	0	0	0	0	0	0	2	0	0
Cyanophyceæ, Anabæna,	29	694	204	34	2,128	11	266	336	1	7	41
Algæ,	2	3	0	4	4	33	3	9	17	20	9
ANIMALS.											
Infusoria,	1	0	1	20	6	1	1	0	0	0	0
Cryptomonas,	0	0	0	12	0	0	0	0	0	0	0
Trachelomonas,	0	0	1	0	4	0	1	0	0	0	0
Vermes,	1	0	0	0	0	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	5	5	3	50	10	3	5	3	7	20	10
TOTAL,	38	702	208	108	2,148	48	275	348	27	47	60

Microscopical Examination of Water from Wannacomet Pond, after Filtration — Concluded.

[Number of organisms per cubic centimeter.]

	1900.										
	Aug.	Aug.	Aug.	Aug.	Sept.	Sept.	Sept.	Sept.	Sept.	Sept.	Sept.
Day of examination,	28	28	28	31	6	8	11	14	14	22	22
Number of sample,	32674	32675	32676	32745	32807	32842	32861	32920	32921	33028	33029
PLANTS.											
Diatomaceæ,	1	0	1	0	0	0	2	0	0	1	0
Cyanophyceæ,	17	206	224	3,320	0	52	12	0	0	0	0
Anabæna,	16	206	224	3,320	0	52	12	0	0	0	0
Algæ,	1	2	5	6	0	6	17	9	7	4	1
ANIMALS.											
Infusoria,	1	0	3	0	0	23	88	273	510	282	392
Cryptomonas,	0	0	0	0	0	0	0	0	0	0	0
Trachelomonas,	1	0	3	0	0	23	88	273	510	282	392
Vermes,	0	0	0	0	0	0	0	0	0	1	0
Miscellaneous, Zoöglœa,	5	15	20	6	3	5	5	8	6	5	3
TOTAL,	25	223	253	3,332	3	86	124	290	523	293	396

NANTUCKET.

Chemical Examination of Water from a Well near Wannacomet Pond, Nantucket.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
33453	Oct. 24	V. slight.	Cons.	.07	10.00	.0078	.0058	2.18	.0050	.0001	.05	2.2	.0250
34160	Dec. 18	None.	None.	.00	7.00	.0060	.0042	2.32	.0400	.0000	.03	1.4	.0100

Odor, none.——The samples were collected from a small well on the shore of Wannacomet Pond, from which water was supplied to the town during part of the year.

Water Supply of Natick.

Chemical Examination of Water from Dug Pond, Natick.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29830	Jan. 1	V. slight.	V. slight.	.06	4.85	1.20	.0152	.0190	.0168	.0022	.66	.0010	.0000	.25	1.8
30076	Jan. 31	Decided.	Cons.	.32	4.55	1.30	.0112	.0202	.0176	.0026	.53	.0060	.0002	.25	1.7
30344	Feb. 28	Decided.	V. slight.	.39	4.65	1.65	.0092	.0186	.0154	.0032	.52	.0120	.0003	.25	1.7
30895	Apr. 2	Slight.	Slight.	.11	4.55	1.30	.0024	.0186	.0154	.0032	.49	.0110	.0002	.25	1.7
31134	Apr. 30	Slight.	Cons.	.12	4.65	1.30	.0064	.0214	.0170	.0044	.50	.0140	.0001	.34	1.8
31433	June 4	Slight.	Slight.	.12	4.95	1.25	.0030	.0238	.0194	.0044	.57	.0110	.0004	.34	1.8
31944	July 3	V. slight.	V. slight.	.08	5.30	1.35	.0032	.0234	.0202	.0032	.47	.0050	.0001	.30	2.0
32375	Aug. 6	V. slight.	Slight	.08	5.15	1.15	.0004	.0202	.0194	.0008	.56	.0000	.0002	.22	2.0
32820	Sept. 4	Slight.	V. slight.	.08	4.85	1.15	.0010	.0200	.0178	.0022	.57	.0010	.0000	.23	1.7
33142	Oct. 1	V. slight.	V. slight.	.10	5.05	1.20	.0008	.0202	.0180	.0022	.55	.0020	.0000	.23	2.1
33564	Nov. 5	None.	V. slight.	.09	4.80	1.00	.0034	.0166	.0160	.0006	.58	.0050	.0000	.18	2.0
33888	Dec. 3	Slight.	V. slight.	.20	4.85	1.00	.0072	.0162	.0150	.0012	.56	.0120	.0002	.25	2.2

Averages by Years.

-	1888	-	-	.13	5.24	1.09	.0070	.0228	-	-	.66	.0197	.0003	-	-
-	1889	-	-	.16	5.55	1.20	.0046	.0242	.0197	.0045	.71	.0292	.0004	-	-
-	1890	-	-	.14	5.85	1.36	.0027	.0199	.0166	.0033	.72	.0227	.0002	-	2.7
-	1891	-	-	.09	5.71	1.45	.0085	.0207	.0167	.0040	.69	.0326	.0003	-	2.4
-	1892	-	-	.06	5.38	1.24	.0068	.0173	.0135	.0038	.72	.0323	.0001	-	2.4
-	1893	-	-	.08	5.28	1.39	.0062	.0192	.0158	.0034	.71	.0193	.0003	.23	2.1
-	1894	-	-	.10	5.64	1.65	.0060	.0155	.0132	.0023	.80	.0218	.0001	.21	2.3
-	1895	-	-	.13	6.27	1.86	.0044	.0191	.0164	.0027	.87	.0312	.0001	.24	2.6
-	1896	-	-	.15	6.19	1.77	.0045	.0176	.0147	.0029	.86	.0290	.0002	.25	2.3
-	1897	-	-	.12	5.41	1.47	.0063	.0192	.0166	.0026	.84	.0130	.0002	.25	2.4
-	1898	-	-	.16	5.21	1.57	.0039	.0168	.0152	.0016	.70	.0127	.0002	.25	2.1
-	1899	-	-	.12	5.09	1.54	.0032	.0195	.0169	.0026	.60	.0158	.0001	.25	2.0
-	1900	-	-	.15	4.85	1.24	.0053	.0198	.0173	.0025	.55	.0067	.0001	.26	1.9

NOTE to analyses of 1900: Odor, generally vegetable or unpleasant, sometimes none.——The samples were collected from a faucet in the pumping station.

NEEDHAM.

Water Supply of Needham.

Chemical Examination of Water from Well Number 1 of the Needham Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1900.												
30233	Feb. 19	None.	None.	.00	6.40	.0006	.0010	.66	.2050	.0000	.02	2.0	.0010
31007	Apr. 15	None.	None.	.00	5.90	.0000	.0006	.70	.2200	.0000	.02	2.1	.0020
31115	Apr. 30	None.	None.	.00	5.70	.0000	.0010	.69	.1800	.0000	.04	1.8	.0030
31240	May 14	None.	None.	.00	6.60	.0006	.0006	.69	.1600	.0000	.03	2.5	.0020
31383	May 28	None.	None.	.00	6.70	.0004	.0012	.68	.1760	.0000	.02	1.7	.0020
31511	June 11	None.	None.	.00	6.50	.0000	.0006	.71	.1680	.0000	.04	1.7	.0040
31839	June 25	None.	None.	.00	6.60	.0000	.0008	.65	.1560	.0000	.04	2.0	.0020
31961	July 9	None.	V. slight.	.00	6.00	.0000	.0006	.63	.1340	.0000	.01	1.7	.0020
32294	July 30	None.	None.	.00	5.80	.0000	.0002	.60	.1500	.0000	.01	1.8	.0020
32452	Aug. 13	None.	V. slight.	.00	5.80	.0000	.0008	.62	.1640	.0000	.02	2.0	.0030
32660	Aug. 27	None.	None.	.00	6.00	.0006	.0014	.64	.1580	.0000	.00	1.8	.0010
32851	Sept. 10	None.	None.	.00	6.00	.0000	.0006	.62	.1500	.0000	.00	1.7	.0050
33041	Sept. 24	None.	V. slight.	.00	6.50	.0000	.0004	.63	.1440	.0000	.01	1.8	.0020
33209	Oct. 8	None.	None.	.01	6.40	.0000	.0012	.63	.1440	.0000	.00	2.0	.0040
33368	Oct. 22	None.	None.	.00	6.30	.0000	.0008	.65	.1800	.0000	.00	1.7	.0030
33554	Nov. 5	None.	None.	.00	6.00	.0000	.0018	.66	.1400	.0000	.01	1.7	.0020
33707	Nov. 19	None.	V. slight.	.00	6.40	.0004	.0022	.67	.1350	.0000	.01	1.8	.0050
33890	Dec. 3	None.	None.	.00	6.20	.0006	.0020	.65	.1450	.0000	.01	2.0	.0090
34105	Dec. 17	None.	None.	.00	6.20	.0000	.0020	.68	.2000	.0000	.01	2.3	.0040
Av.*.	....	....	....	.00	6.22	.0002	.0010	.65	.1657	.0000	.01	1.9	0029

Odor of No. 34105, faintly earthy; of the others, none. —— This well is the original source of supply of the Needham water works.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Chemical Examination of Water from Well Number 2 of the Needham Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1900.												
31116	Apr. 30	V. slight.	V. slight.	.00	7.90	.0000	.0012	.85	.2800	.0000	.04	2.6	.0050
31384	May 28	None.	V. slight.	.00	7.60	.0002	.0040	.65	.2040	.0001	.02	3.0	.0040
31512	June 11	None.	V. slight.	.01	9.50	.0042	.0026	.69	.1480	.0014	.02	3.5	.0040
31840	June 25	V. slight.	V. slight.	.02	10.10	.0014	.0050	.68	.2080	.0020	.05	3.3	.0040
31962	July 9	None.	None.	.00	6.40	.0004	.0006	.65	.1240	.0000	.01	2.2	.0030
32295	July 30	None.	None.	.00	6.70	.0000	.0006	.65	.1280	.0000	.01	2.0	.0020
32453	Aug. 13	None.	None.	.00	6.50	.0010	.0010	.64	.1640	.0000	.02	2.3	.0040
32661	Aug. 27	None.	None.	.00	6.70	.0010	.0008	.67	.1500	.0001	.00	2.5	.0020
32852	Sept. 10	None.	None.	.00	7.40	.0006	.0008	.65	.1550	.0001	.00	2.5	.0030
33042	Sept. 24	None.	None.	.00	6.10	.0004	.0008	.64	.1280	.0000	.01	2.0	.0020
33210	Oct. 8	None.	None.	.02	7.10	.0000	.0006	.63	.1300	.0000	.00	2.0	.0040
33369	Oct. 22	None.	None.	.00	6.40	.0000	.0012	.65	.1640	.0000	.00	1.8	.0070
33555	Nov. 5	None.	None.	.00	6.30	.0000	.0020	.68	.1500	.0000	.01	1.7	.0020
33708	Nov. 19	None.	None.	.00	6.80	.0000	.0018	.69	.1450	.0000	.02	2.0	.0040
33891	Dec. 3	None.	None.	.00	6.80	.0004	.0022	.71	.3000	.0000	.01	2.6	.0080
34106	Dec. 17	None.	None.	.00	6.40	.0000	.0012	.71	.2600	.0000	.01	2.0	.0040
Av.*.	....	....	....	.00	7.23	.0005	.0017	.68	.1846	.0002	.01	2.4	.0039

Odor, none. —— The samples were collected from well No. 2, the new source of supply of the Needham water works. Water from this well is supplied by pumping into well No. 1.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Water Supply of New Bedford.

Chemical Examination of Water from Little Quittacas Pond, Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30014	Jan. 22	Slight.	Slight.	.22	3.35	1.50	.0004	.0172	.0144	.0028	.50	.0010	.0000	.38	0.8
30316	Feb. 26	V. slight.	Slight.	.24	3.05	1.45	.0002	.0178	.0164	.0014	.47	.0010	.0000	.43	0.5
30737	Mar. 26	V. slight.	Cons.	.24	3.25	1.15	.0002	.0168	.0150	.0018	.49	.0010	.0001	.43	0.6
31072	Apr. 23	V. slight.	Cons.	.22	3.30	1.25	.0006	.0152	.0138	.0014	.51	.0020	.0000	.47	0.5
31391	May 28	V. slight.	V. slight.	.28	3.05	1.00	.0010	.0180	.0174	.0006	.52	.0010	.0001	.49	0.6
31852	June 25	V. slight.	Slight.	.31	3.65	1.15	.0006	.0180	.0164	.0016	.48	.0010	.0000	.48	0.5
32301	July 30	Slight.	V. slight.	.19	3.85	1.25	.0006	.0186	.0162	.0024	.50	.0000	.0000	.44	0.6
32678	Aug. 27	V. slight.	V. slight.	.16	3.30	1.05	.0014	.0204	.0178	.0026	.54	.0020	.0000	.38	0.6
33080	Sept. 25	V. slight.	V. slight.	.18	3.30	1.15	.0002	.0170	.0162	.0008	.55	.0040	.0000	.37	0.5
33442	Oct. 24	None.	V. slight.	.12	3.20	1.00	.0006	.0186	.0164	.0022	.56	.0020	.0000	.31	0.5
33838	Nov. 27	V. slight.	V. slight.	.14	3.05	1.15	.0018	.0158	.0154	.0004	.56	.0040	.0000	.35	0.8
34241	Dec. 26	V. slight.	V. slight.	.14	3.50	1.40	.0010	.0164	.0146	.0018	.57	.0050	.0000	.46	0.6

Averages by Years.

-	1893	-	-	.11	3.02	1.23	.0015	.0156	.0128	.0028	.48	.0025	.0000	.29	0.6
-	1894	-	-	.18	2.91	0.95	.0002	.0165	.0137	.0028	.48	.0008	.0000	.31	0.7
-	1895	-	-	.18	3.17	1.25	.0008	.0162	.0137	.0025	.51	.0037	.0000	.31	0.7
-	1896	-	-	.21	3.17	1.27	.0003	.0194	.0157	.0037	.53	.0033	.0000	.36	0.7
-	1897	-	-	.18	3.04	1.07	.0007	.0188	.0146	.0042	.56	.0020	.0000	.30	0.7
-	1898	-	-	.21	3.31	1.32	.0002	.0175	.0150	.0025	.55	.0007	.0000	.35	1.1
-	1899	-	-	.20	3.33	1.44	.0012	.0183	.0165	.0018	.47	.0010	.0000	.37	0.5
-	1900	-	-	.20	3.32	1.21	.0007	.0175	.0158	.0017	.52	.0020	.0000	.42	0.6

Note to analyses of 1900: Odor, faintly vegetable or none.

NEW BEDFORD.

Chemical Examination of Water from Great Quittacas Pond, Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30317	Feb. 26	None.	Cons.	.39	3.25	1.25	.0000	.0184	.0162	.0022	.47	.0000	.0000	.60	0.6
31390	May 28	V. slight.	V. slight.	.48	3.10	1.10	.0006	.0178	.0174	.0004	.52	.0010	.0001	.70	0.5
32677	Aug. 27	V. slight.	Slight.	.30	3.50	1.15	.0008	.0180	.0166	.0014	.53	.0020	.0000	.28	0.3
33836	Nov. 27	V. slight.	V. slight.	.29	2.90	1.00	.0020	.0146	.0144	.0002	.54	.0010	.0000	.53	0.8

Averages by Years.

-	1894	-	-	.49	3.30	1.35	.0002	.0154	.0139	.0015	.50	.0017	.0000	.50	0.6
-	1895	-	-	.40	3.30	1.22	.0001	.0154	.0133	.0021	.53	.0020	.0000	.52	0.6
-	1896	-	-	.52	3.82	1.67	.0005	.0198	.0173	.0025	.55	.0030	.0000	.75	0.7
-	1897	-	-	.54	3.56	1.47	.0005	.0160	.0148	.0012	.58	.0002	.0000	.58	0.7
-	1898	-	-	.65	3.81	2.00	.0005	.0197	.0180	.0017	.57	.0005	.0000	.77	0.9
-	1899	-	-	.43	3.53	1.64	.0006	.0182	.0164	.0018	.49	.0012	.0000	.60	0.4
-	1900	-	-	.36	3.19	1.12	.0008	.0172	.0161	.0011	.51	.0010	.0000	.53	0.5

NOTE to analyses of 1900: Odor, vegetable or none.

Chemical Examination of Water from a Faucet at City Hall, New Bedford.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30005	Jan. 22	V. slight.	V. slight.	.21	3.30	1.40	.0004	.0148	.0142	.0006	.49	.0010	.0000	.34	0.5
30353	Feb. 28	V. slight.	V. slight.	.23	3.30	1.45	.0010	.0164	.0138	.0026	.49	.0000	.0000	.39	0.5
30721	Mar. 26	V. slight.	V. slight.	.22	3.15	1.30	.0004	.0166	.0152	.0014	.48	.0010	.0000	.43	0.6
31386	May 28	V. slight.	Slight.	.24	3.15	1.05	.0014	.0172	.0158	.0014	.51	.0020	.0002	.43	0.8
31831	June 22	V. slight.	Slight.	.25	3.40	1.15	.0010	.0194	.0180	.0014	.50	.0010	.0001	.47	0.6
32298	July 30	Slight.	Slight.	.19	3.85	1.65	.0002	.0192	.0166	.0026	.48	.0010	.0000	.40	0.5
32681	Aug. 27	V. slight.	V. slight.	.14	3.35	1.10	.0006	.0190	.0174	.0016	.50	.0020	.0000	.35	0.8
33066	Sept. 25	V. slight.	Slight.	.20	3.20	1.00	.0006	.0172	.0158	.0014	.55	.0020	.0000	.35	0.5
33411	Oct. 24	None.	Slight.	.13	3.40	1.00	.0012	.0184	.0174	.0010	.54	.0020	.0000	.33	0.6
33825	Nov. 27	V. slight.	None.	.13	3.05	1.05	.0020	.0152	.0150	.0002	.56	.0040	.0000	.34	0.8
34221	Dec. 26	None.	V slight.	.11	3.00	0.90	.0020	.0164	.0146	.0018	.57	.0020	.0000	.42	0.6
Av...	....	....	....	.19	3.29	1.19	.0010	.0173	.0158	.0015	.52	.0016	.0000	.39	0.6

Odor, none, generally becoming faintly vegetable or unpleasant, and in March faintly fishy, on heating.

NEW BEDFORD.

Chemical Examination of Water from Long Pond, Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30318	Feb. 26	Slight.	Slight.	0.78	3.95	2.05	.0006	.0230	.0206	.0024	.47	.0010	.0000	0.98	0.3
31392	May 28	V. slight.	V. slight.	1.20	3.95	2.10	.0004	.0200	.0188	.0012	.47	.0010	.0001	1.18	0.6
32679	Aug. 27	V. slight.	V. slight.	0.40	3.30	1.30	.0008	.0188	.0176	.0012	.50	.0030	.0000	0.69	0.2
33837	Nov. 27	Slight.	Slight.	0.32	3.10	1.50	.0022	.0168	.0162	.0006	.55	.0020	.0000	0.60	0.5
Av...	....	....	....	0.67	3.57	1.74	.0010	.0196	.0183	.0013	.50	.0017	.0000	0.86	0.4

Odor of No. 32679, faintly unpleasant; of the others, faintly vegetable, becoming stronger on heating. —— This pond is not used as a source of water supply.

Water Supply of Newburyport.

Chemical Examination of Water from the Newburyport Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29948	Jan. 15	Decided.	Cons.	.05	5.80	.0000	.0018	.50	.0110	.0000	.08	2.3	.1650
30631	Mar. 19	Slight.	Slight.	.08	5.70	.0000	.0036	.44	.0220	.0000	.06	1.8	.0210
31243	May 14	Decided.	Cons.	.10	6.10	.0006	.0040	.49	.0210	.0001	.09	2.3	.0540
32299	July 30	V. slight.	Slight.	.05	5.90	.0000	.0016	.47	.0210	.0000	.03	2.2	.0100
33059	Sept. 24	Slight.	V. slight.	.06	6.00	.0006	.0020	.46	.0210	.0000	.02	2.1	.0360
33802	Nov. 26	V. slight.	V. slight.	.09	5.90	.0002	.0040	.48	.0300	.0000	.05	2.9	.0280
Av...	....	....	....	.07	5.90	.0002	.0028	.47	.0210	.0000	.05	2.3	.0523

Odor, none. A faintly vegetable odor was developed in No. 33059 on heating. —— The samples were collected from a faucet in the town.

NEWTON.

Water Supply of Newton.

Chemical Examination of Water from a Faucet at the Newton Water Works Pumping Station.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1900.												
29949	Jan. 15	None.	None.	.00	6.40	.0006	.0024	.50	.0120	.0000	.06	3.0	.0020
30628	Mar. 19	None.	None.	.00	5.00	.0000	.0022	.42	.0300	.0000	.07	2.0	.0010
31287	May 17	None.	None.	.01	5.40	.0004	.0022	.41	.0310	.0000	.07	2.2	.0020
32308	July 31	None.	None.	.02	5.80	.0002	.0024	.42	.0210	.0000	.08	2.3	.0010
32957	Sept. 18	None.	None.	.07	5.20	.0006	.0102	.49	.0030	.0000	.17	1.4	.0050
33043	Sept. 24	None.	V. slight.	.05	5.80	.0006	.0028	.46	.0210	.0000	.09	2.2	.0080
33808	Nov. 26	None.	None.	.01	6.50	.0006	.0024	.48	.0390	.0000	.05	2.6	.0050
Av.*.	....	....	....	.02	5.77	.0004	.0030	.45	.0242	.0000	.08	2.3	.0029

Odor, none.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Water Supply of Woodland Park Hotel, Newton.

The advice of the State Board of Health to the proprietor of the Woodland Park Hotel, relative to the quality of the water of a tubular well from which it is proposed to obtain water for domestic purposes, may be found on page 29 of this volume. The results of analyses of samples of water collected from the well are given in the following table: —

Chemical Examination of Water from a Well at the Woodland Park Hotel, Newton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1900.												
32901	Sept. 12	V. slight.	V. slight.	.02	20.60	.0014	.0010	2.93	.4800	.0012	.02	8.6	.0140
33033	Sept. 20	None.	None.	.00	19.60	.0000	.0006	2.65	.4800	.0011	.01	7.3	.0070
34249	Dec. 27	V. slight.	None.	.05	18.40	.0014	.0024	1.87	.6300	.0012	.02	7.0	.0160

Odor of the first sample, none, becoming very faintly unpleasant on heating; of the others, none. —— The samples were collected from a driven well on the premises of the Woodland Park Hotel, Auburndale, Newton.

Water Supply of North Adams.

Chemical Examination of Water from Notch Brook Storage Reservoir, North Adams.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30195	Feb. 10	Slight.	Cons.	.09	5.00	1.30	.0240	.0120	.0078	.0042	.09	.0050	.0001	.20	3.1
31162	May 1	Slight.	Cons.	.04	5.50	0.60	.0066	.0090	.0070	.0020	.07	.0020	.0000	.10	3.8
32465	Aug. 10	V. slight.	Slight.	.02	8.60	1.00	.0024	.0092	.0080	.0012	.08	.0020	.0000	.11	6.6
33853	Nov. 27	Decided.	Slight.	.10	9.50	3.50	.0006	.0096	.0092	.0004	.08	.0040	.0001	.18	5.9
Av...	....	....	....	.06	7.15	1.60	.0084	.0099	.0080	.0019	.08	.0032	.0000	.15	4.8

Odor of the first and third samples, faintly vegetable, becoming stronger on heating; of the second, faintly unpleasant; of the last, none.

Chemical Examination of Water from Broad Brook in Pownal, Vt.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30194	Feb. 10	None.	V. slight.	.14	3.40	1.30	.0008	.0054	.0054	.0000	.07	.0190	.0000	.32	1.3
31161	May 2	V. slight.	V. slight.	.11	3.15	0.95	.0000	.0046	.0046	.0000	.06	.0130	.0000	.23	1.4
32464	Aug. 11	V. slight.	V. slight.	.22	4.50	1.40	.0076	.0132	.0104	.0028	.12	.0120	.0000	.47	2.3
33852	Nov. 27	V. slight.	V. slight.	.42	3.35	1.80	.0012	.0154	.0144	.0010	.09	.0220	.0001	.78	1.1
Av...	....	....	....	.22	3.60	1.36	.0024	.0096	.0087	.0009	.08	.0165	.0000	.45	1.5

Odor, faintly vegetable or none.

The advice of the State Board of Health to the board of health of North Adams, relative to the use of Cheshire Reservoir in Cheshire as a source of ice supply, may be found on page 98 of this volume. The results of analyses of samples of water collected from this reservoir are given under "Cheshire."

The advice of the Board, relative to the quality of the ice supplied by the Hygeia Ice and Cold Storage Company, may be found on pages 99 and 100 of this volume.

NORTHAMPTON.

WATER SUPPLY OF NORTHAMPTON.

The advice of the State Board of Health to the city of Northampton, relative to a proposed additional water supply for that city, may be found on page 29 of this volume. The results of analyses of samples of water from various sources, collected during the investigations, and of samples from the present sources of supply, are given in the following tables: —

Chemical Examination of Water from the Middle Storage Reservoir on Roberts' Meadow Brook, collected near the Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30015	Jan. 23	Decided.	Slight.	.33	3.35	1.40	.0010	.0170	.0148	.0022	.09	.0020	.0001	.57	0.8
30315	Feb. 26	Decided.	Slight.	.34	2.65	1.30	.0010	.0160	.0148	.0012	.08	.0010	.0001	.52	0.3
30801	Mar. 27	V. slight.	V. slight.	.12	2.85	0.95	.0000	.0090	.0074	.0016	.08	.0030	.0001	.28	1.1
31091	Apr. 24	V. slight.	V. slight.	.23	3.30	1.05	.0006	.0114	.0108	.0006	.10	.0010	.0000	.38	1.1
31856	June 26	V. slight.	Slight.	.10	3.65	1.00	.0006	.0130	.0104	.0026	.09	.0010	.0000	.26	1.4
32348	July 31	V. slight.	V. slight.	.09	3.75	1.15	.0006	.0166	.0132	.0034	.10	.0000	.0000	.34	1.6
32714	Aug. 28	Slight.	Slight.	.13	4.25	1.25	.0010	.0202	.0150	.0052	.10	.0010	.0000	.33	2.0
33074	Sept. 25	Decided.	Cons.	.30	4.15	1.00	.0012	.0240	.0140	.0100	.12	.0010	.0000	.34	2.1
33405	Oct. 23	Slight.	Cons.	.31	5.30	0.90	.0020	.0244	.0120	.0124	.14	.0020	.0001	.32	2.2
33739	Nov. 20	Slight.	Slight.	.40	6.00	1.85	.0052	.0252	.0192	.0060	.20	.0070	.0000	.64	2.1
33792	Nov. 23	Slight.	V. slight.	.36	5.95	1.75	.0028	.0182	.0152	.0030	.19	.0050	.0000	.61	2.2
34166	Dec. 19	V. slight.	V. slight.	.29	4.80	1.75	.0008	.0136	.0122	.0014	.11	.0070	.0000	.54	1.6

Averages by Years.

-	1895	-	-	.57	4.56	1.72	.0008	.0181	.0156	.0025	.13	.0024	.0000	.61	1.8
-	1896	-	-	.25	3.89	1.27	.0004	.0121	.0092	.0029	.10	.0047	.0000	.34	1.7
-	1897	-	-	.29	3.90	1.31	.0013	.0116	.0103	.0013	.11	.0023	.0000	.35	1.6
-	1898	-	-	.30	3.84	1.45	.0013	.0126	.0101	.0025	.10	.0037	.0000	.43	1.4
-	1899	-	-	.22	3.85	1.32	.0010	.0134	.0109	.0025	.09	.0023	.0001	.35	1.4
-	1900*	-	-	.24	4.00	1.23	.0012	.0170	.0129	.0041	.11	.0023	.0000	.41	1.5

NOTE to analyses of 1900: Odor, generally faintly vegetable or none, occasionally unpleasant. A vegetable odor was developed in all of the samples on heating.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NORTHAMPTON.

Chemical Examination of Water from Various Streams near Northampton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
33353	Oct. 17	V. slight.	Slight.	.23	5.40	1.30	.0004	.0108	.0100	.0008	.17	.0010	.0001	.31	2.0
33351	Oct 16	None.	V. slight.	.15	5.40	1.05	.0002	.0076	.0072	.0004	.15	.0090	.0000	.32	2.2
33352	Oct. 16	None.	V. slight.	.10	5.20	1.10	.0012	.0082	.0068	.0014	.16	.0010	.0001	.19	2.3
33348	Oct. 16	None.	Slight.	.38	7.25	1.50	.0018	.0166	.0144	.0022	.17	.0010	.0002	.49	3.4
33354	Oct. 17	None.	None.	.10	4.85	1.00	.0018	.0096	.0092	.0004	.15	.0010	.0000	.24	1.6
33383	Oct. 20	None.	V. slight.	.10	4.45	0.85	.0004	.0066	.0062	.0004	.12	.0220	.0000	.17	2.5
33384	Oct. 20	None.	V. slight.	.12	3.10	1.20	.0014	.0090	.0086	.0004	.10	.0040	.0000	.21	1.4
33349	Oct. 17	None.	V. slight.	.20	4.45	1.50	.0018	.0084	.0080	.0004	.16	.0010	.0000	.31	2.1
33350	Oct. 17	None.	V. slight.	.10	4.50	1.40	.0002	.0066	.0060	.0006	.15	.0050	.0000	.22	1.7

Odor of Nos. 33351, 33352, 33353 and 33354, faintly musty, becoming stronger on heating; of the others, none, becoming vegetable or musty on heating.—— These samples were collected in connection with an investigation for an additional water supply for the city of Northampton. No. 33353 was collected from Roberts' Meadow Brook, above the middle reservoir, which is the present source of water supply of the city; Nos. 33351 and 33352 were collected respectively from the north and south branches of West Brook, just above their confluence at West Whately; No. 33348 was collected from Beaver Brook, at the point where it is crossed by the road from Hatfield to Williamsburg; No. 33354, from the east branch of Mill River, at the site of a former storage reservoir above the mouth of Bradford Brook; No. 33383, from the east branch of Mill River, about a mile above Williamsburg; No. 33384, from the west branch of Mill River, at the saw-mill pond above Searsville; No. 33349, from North Brook in Westhampton, above its junction with Sodden Brook; No. 33350, from Sodden Brook in Westhampton, at the first road crossing above the mouth of North Brook.

Water Supply of Northampton Insane Hospital.

The advice of the State Board of Health to the superintendent of the Northampton Insane Hospital, relative to the quality of the water of a spring used as a source of water supply for the hospital, may be found on page 33 of this volume. The results of analyses of samples of water collected during the investigation are given in the following table: —

Chemical Examination of Water from a Spring at the Northampton Insane Hospital.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
31304	May 18	None.	V. slight.	.00	23.70	.0000	.0014	2.01	1.2800	.0000	.01	7.0	.2800
31496	June 5	None.	None.	.00	24.50	.0006	.0034	1.98	1.5000	.0001	.02	8.0	.0030

Odor, none.—— The samples were collected from a spring from which water is drawn for the supply of the hospital.

NORTH ANDOVER.

Water Supply of North Andover.

Chemical Examination of Water from Great Pond, North Andover.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30054	Jan. 29	V. slight.	V. slight.	.09	3.50	1.35	.0002	.0194	.0180	.0014	.30	.0010	.0000	.33	1.1
30836	Mar. 28	Slight.	V. slight.	.12	3.20	1.40	.0002	.0186	.0152	.0034	.30	.0020	.0000	.36	1.1
31357	May 23	V. slight.	V. slight.	.11	3.80	1.30	.0028	.0158	.0152	.0006	.34	.0070	.0000	.36	1.1
32287	July 30	V. slight.	Slight.	.07	3.05	0.85	.0004	.0172	.0158	.0014	.32	.0010	.0000	.35	1.0
33054	Sept. 24	V. slight.	V. slight.	.10	3.40	0.85	.0014	.0174	.0142	.0032	.33	.0010	.0000	.31	1.1
33830	Nov. 27	V. slight.	V. slight.	.09	3.00	1.10	.0020	.0158	.0150	.0008	.34	.0040	.0000	.30	1.6
Av...	....	....	....	.10	3.32	1.14	.0012	.0174	.0156	.0018	.32	.0027	.0000	.33	1.2

Odor, none, becoming faintly unpleasant in the second sample, and faintly vegetable in the fourth and fifth samples, on heating.——No. 30836 was collected from a faucet at the pumping station; the others, from the pond.

Water Supply of North Attleborough.

Chemical Examination of Water from the Well of the North Attleborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30133	Feb. 6	None.	None.	.00	5.80	.0000	.0010	.63	.0650	.0000	.04	2.6	.0030
31005	Apr. 12	None.	None.	.00	6.70	.0004	.0012	.63	.0500	.0000	.04	2.7	.0080
31395	May 28	None.	V. slight.	.00	5.70	.0004	.0018	.66	.0520	.0000	.04	3.0	.0080
32366	Aug. 3	None.	None.	.00	7.50	.0000	.0002	.66	.0600	.0000	.03	2.7	.0040
33187	Oct. 3	None.	V. slight.	.02	6.20	.0002	.0018	.57	.0430	.0000	.02	2.6	.0100
33858	Nov. 30	None.	V. slight.	.00	5.90	.0000	.0012	.54	.0410	.0000	.01	3.0	.0110
Av...	....	....	....	.00	6.30	.0002	.0012	.61	.0518	.0000	.03	2.8	.0073

Odor, none.——The samples were collected from a faucet at the pumping station.

Water Supply of Northborough.

Chemical Examination of Water from the Upper Reservoir of the Northborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30319	Feb. 26	Slight.	Slight.	0.76	3.35	1.55	.0006	.0196	.0188	.0008	.16	.0010	.0000	0.79	0.6
31332	May 21	Slight.	V. slight.	1.20	4.15	2.20	.0006	.0258	.0244	.0014	.14	.0010	.0000	1.13	0.6
32682	Aug. 27	V. slight.	Slight.	0.60	4.10	1.80	.0030	.0350	.0284	.0066	.26	.0030	.0000	0.85	0.6
33803	Nov. 26	Decided.	Slight.	0.64	4.15	1.90	.0024	.0268	.0240	.0028	.23	.0060	.0000	0.82	0.8
Av...	....	....	....	0.80	3.94	1.86	.0016	.0268	.0239	.0029	.20	.0027	.0000	0.90	0.7

Odor, faintly vegetable, becoming stronger, and in the last sample distinctly unpleasant, on heating.

Chemical Examination of Water from the Lower Reservoir of the Northborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30330	Feb. 27	Decided.	Slight.	.55	3.00	1.40	.0016	.0232	.0204	.0028	.17	.0020	.0001	.74	0.3
31333	May 21	Slight.	Slight.	.95	3.60	1.60	.0004	.0208	.0190	.0018	.15	.0010	.0000	.82	0.5
32683	Aug. 27	Decided.	Cons.	.50	3.50	1.35	.0030	.0326	.0234	.0092	.25	.0020	.0000	.69	0.6
33804	Nov. 26	Slight.	Slight.	.48	4.15	1.75	.0024	.0244	.0196	.0048	.28	.0030	.0000	.68	1.0
Av...	....	....	....	.62	3.56	1.52	.0018	.0252	.0206	.0046	.21	.0020	.0000	.73	0.6

Odor, faintly vegetable or unpleasant, becoming stronger in the second sample, and oily in the last sample, on heating.

NORTH BROOKFIELD.

Water Supply of North Brookfield.

Chemical Examination of Water from Doane Pond, North Brookfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29968	Jan. 17	Decided.	Slight.	.21	2.90	1.90	.0138	.0226	.0196	.0030	.12	.0060	.0002	.35	0.5
31039	Apr. 18	Decided.	Cons.	.36	2.80	1.30	.0094	.0240	.0194	.0046	.12	.0030	.0001	.46	0.5
32290	July 30	Decided.	Cons.	.84	3.25	1.40	.0036	.0428	.0316	.0112	.11	.0020	.0000	.74	0.3
33574	Nov. 5	V. slight.	V. slight.	.70	3.65	1.60	.0312	.0340	.0288	.0052	.15	.0090	.0005	.51	0.3

Averages by Years.

-	1894	-	-	.91	4.24	1.77	.0110	.0353	.0280	.0073	.19	.0054	.0001	.62	1.1
-	1895	-	-	.51	4.92	1.60	.0076	.0365	.0285	.0080	.22	.0102	.0002	.51	1.7
-	1896	-	-	.43	3.74	1.48	.0012	.0288	.0247	.0041	.15	.0054	.0000	.51	1.1
-	1897	-	-	.57	3.59	1.52	.0031	.0305	.0254	.0051	.16	.0053	.0000	.50	0.8
-	1898	-	-	.55	3.50	1.53	.0069	.0241	.0204	.0037	.16	.0043	.0001	.51	0.9
-	1899	-	-	.44	2.77	1.33	.0079	.0264	.0229	.0035	.11	.0030	.0001	.45	0.4
-	1900	-	-	.53	3.15	1.55	.0145	.0308	.0248	.0060	.12	.0050	.0002	.51	0.4

Note to analyses of 1900: Odor, faintly vegetable or none. A vegetable or unpleasant odor was developed in all of the samples on heating.

Chemical Examination of Water from North Pond, North Brookfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29969	Jan. 17	Decided.	Cons.	.26	4.70	1.85	.0282	.0300	.0208	.0092	.14	.0190	.0004	.47	1.4
31038	Apr. 18	Decided.	Cons.	.29	2.50	1.15	.0042	.0206	.0184	.0022	.11	.0030	.0000	.39	0.3
32291	July 30	Decided.	Cons.	.54	3.00	1.15	.0032	.0316	.0256	.0060	.11	.0010	.0001	.69	0.2
33575	Nov. 5	Slight.	Cons.	.48	4.00	1.50	.0108	.0444	.0356	.0088	.28	.0110	.0001	.50	0.6
Av...	....	....	....	.39	3.55	1.41	.0116	.0316	.0251	.0065	.16	.0085	.0001	.51	0.6

Odor of the last sample, unpleasant, becoming stronger on heating; of the others, faintly vegetable or none.

Water Supply of Northfield. — Northfield Water Company.

Chemical Examination of Water from the Reservoir of the Northfield Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30148	Feb. 7	V. slight.	None.	.21	2.55	1.05	.0000	.0068	.0066	.0002	.12	.0040	.0001	.39	0.3
30931	Apr. 4	None.	V. slight.	.14	2.10	0.75	.0000	.0040	.0032	.0008	.09	.0020	.0000	.26	0.2
31480	June 6	Slight.	Slight.	.35	3.10	1.15	.0004	.0098	.0094	.0004	.09	.0040	.0000	.52	0.6
32759	Aug. 30	None.	V. slight.	.01	3.10	0.65	.0000	.0028	.0026	.0002	.10	.0020	.0000	.07	1.0
33455	Oct. 25	None.	Slight.	.18	3.85	0.95	.0000	.0046	.0044	.0002	.12	.0000	.0000	.13	1.3
34164	Dec. 20	V. slight.	None.	.10	3.20	1.05	.0010	.0056	.0054	.0002	.10	.0010	.0000	.26	1.6
Av...	....	....	....	.16	2.98	0.93	.0002	.0056	.0053	.0003	.10	.0022	.0000	.27	0.8

Odor in June and October, unpleasant; at other times, vegetable or none.

Water Supply of Northfield Seminary, Northfield.

The advice of the State Board of Health to A. G. Moody of Northfield, relative to a proposed additional water supply for the Northfield Seminary and also for the village of East Northfield, may be found on page 33 of this volume. The results of analyses of samples of water collected from the present sources of supply and from the proposed additional sources are given in the following tables: —

Chemical Examination of Water from the Sources of Supply of the Northfield Seminary, Northfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
33117	Sept. 28	V. slight.	None.	.18	4.50	1.00	.0018	.0034	.0026	.0008	.31	.0380	.0004	.06	1.7
33118	Sept. 28	None.	None.	.00	11.10	–	.0008	.0014	–	–	.87	.2050	.0001	.01	4.0
33873	Dec. 1	V. slight.	V. slight.	.03	7.85	1.55	.0016	.0042	.0040	.0002	.77	.1060	.0001	.07	3.8

Odor, none. —— The first sample was collected from a faucet at the pumping station supplied from Louisiana Brook and from a spring near the brook; the last two, from a faucet at the laundry supplied from driven wells.

NORTHFIELD SEMINARY.

Chemical Examination of Water from Perchog and Louisiana Brooks in Northfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1900.														
33119	Sept. 28	V. slight.	None.	.26	3.95	1.30	.0008	.0138	.0130	.0008	.11	.0000	.0000	.51	1.3
33872	Dec. 1	None.	Slight.	.22	2.60	1.00	.0008	.0088	.0074	.0014	.14	.0060	.0000	.37	1.1
33120	Sept. 28	None.	V. slight.	.14	3.90	1.00	.0002	.0066	.0056	.0010	.09	.0020	.0000	.23	1.1
33871	Dec. 1	None.	Slight.	.10	2.40	0.90	.0000	.0044	.0042	.0002	.13	.0030	.0000	.20	0.8
33870	Dec. 1	None.	V. slight.	.08	2.50	1.00	.0014	.0058	.0036	.0022	.17	.0150	.0001	.12	1.3

Odor of the third sample, very faintly unpleasant; of the others, none, becoming faintly vegetable in the first sample on heating. —— The first sample was collected from Perchog Brook, near the line between Massachusetts and New Hampshire; the second, from Perchog Brook, a short distance above its mouth; the third and fourth, from Louisiana Brook, at a point about a mile above its junction with Perchog Brook; the last, from Louisiana Brook, just above the Northfield Seminary pumping station, and a short distance above its junction with Perchog Brook.

Water Supply of Norwood.

The advice of the State Board of Health to the town of Norwood, relative to the quality of the water supply of the town, may be found on page 38 of this volume. The advice of the Board relative to an

Chemical Examination of Water from Buckmaster Pond, Dedham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1900.														
29837	Jan. 2	Slight.	V. slight.	.21	3.85	1.30	.0216	.0222	.0180	.0042	.32	.0030	.0001	.16	0.8
29858	Jan. 4	Slight.	V. slight.	.12	3.35	0.80	.0184	.0148	.0124	.0024	.31	.0040	.0001	.12	0.8
30116	Feb. 5	Decided.	Slight.	.15	3.50	1.00	.0276	.0228	.0154	.0074	.30	.0060	.0001	.15	0.6
30373	Mar. 5	Slight.	Cons.	.20	3.35	1.00	.0130	.0260	.0182	.0078	.21	.0010	.0001	.25	0.5
30910	Apr. 3	Slight.	Slight.	.10	2.75	1.00	.0006	.0220	.0158	.0062	.30	.0060	.0002	.31	0.6
31119	Apr. 30	V. slight	Cons.	.10	2.85	0.90	.0004	.0196	.0154	.0042	.28	.0010	.0000	.30	0.5
31461	June 5	V. slight.	None.	.13	2.70	1.10	.0010	.0180	.0158	.0022	.29	.0030	.0001	.30	0.6
31919	July 2	Slight.	Slight.	.11	2.70	0.90	.0004	.0220	.0198	.0022	.27	.0010	.0000	.33	0.5
32373	Aug. 6	V. slight.	V. slight.	.34	2.75	0.85	.0004	.0134	.0126	.0008	.22	.0000	.0000	.39	0.0
32788	Sept. 3	Slight.	Slight.	.11	3.35	1.10	.0014	.0270	.0236	.0034	.32	.0020	.0000	.27	0.3
33165	Oct. 2	Slight.	Cons.	.12	3.25	1.20	.0116	.0242	.0214	.0028	.33	.0050	.0000	.29	0.5
33594	Nov. 6	V. slight.	Cons.	.11	3.10	0.90	.0338	.0322	.0174	.0148	.35	.0070	.0001	.24	0.3
33925	Dec. 4	Slight.	Slight.	.11	3.50	1.80	.0286	.0176	.0150	.0026	.31	.0040	.0002	.20	1.0
Av.*.	....	....	....	.14	3.12	1.07	.0116	.0220	.0172	.0048	.29	.0033	.0001	.26	0.5

Odor, generally faintly vegetable or none, occasionally unpleasant. A vegetable or unpleasant odor was developed in all of the samples on heating.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

additional water supply, to be taken from driven wells in the valley of Purgatory Brook, may be found on page 35 of this volume. The results of analyses of samples of water from the present source of supply and from the tubular test wells are given in the foregoing and following tables : —

Chemical Examination of Water from Colburn Brook, Westwood.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29838	Jan. 2	None.	V. slight.	1.00	5.10	2.40	.0008	.0202	.0194	.0008	.27	.0030	.0000	1.14	0.5
30117	Feb. 5	V. slight.	Slight.	0.92	4.35	2.35	.0012	.0224	.0202	.0022	.27	.0040	.0000	1.15	0.5
30374	Mar. 5	V. slight.	V. slight.	0.55	2.90	1.40	.0002	.0134	.0132	.0002	.13	.0010	.0000	0.68	0.0
30911	Apr. 3	V. slight.	V. slight.	0.82	3.15	1.50	.0004	.0128	.0116	.0012	.25	.0000	.0001	0.78	0.3
31118	Apr. 30	None.	V. slight.	1.20	3.80	2.10	.0002	.0176	.0174	.0002	.24	.0010	.0000	1.22	0.2
31460	June 5	V. slight.	V. slight.	1.90	4.55	2.75	.0006	.0238	.0228	.0010	.21	.0000	.0000	1.70	0.8
31918	July 2	None.	V. slight.	1.24	4.15	2.05	.0002	.0204	.0194	.0010	.23	.0010	.0001	0.76	0.2
32374	Aug. 6	V. slight.	Slight.	0.11	2.95	1.00	.0002	.0246	.0204	.0042	.23	.0010	.0000	0.33	0.5
32789	Sept. 3	V. slight.	V. slight.	0.28	3.40	0.90	.0006	.0122	.0108	.0014	.26	.0000	.0000	0.34	0.2
33199	Oct. 4	None.	Slight.	0.47	3.70	1.10	.0026	.0152	.0148	.0004	.30	.0020	.0000	0.49	0.5
33595	Nov. 6	None.	V. slight.	0.46	7.05	2.25	.0030	.0222	.0216	.0006	.40	.0040	.0000	0.79	1.4
33926	Dec. 4	None.	V. slight.	1.15	5.50	3.15	.0016	.0220	.0210	.0010	.33	.0040	.0000	1.59	1.3
Av...	....	....	....	0.84	4.22	1.91	.0010	.0189	.0177	.0012	.26	.0017	.0000	0.91	0.5

Odor, generally faintly vegetable or none, sometimes unpleasant. On heating, the odor of most of the samples became stronger. —— This brook is not used as a source of water supply.

Chemical Examination of Water from Tubular Test Wells in the Valley of Purgatory Brook, Norwood.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1899.												
29577	Dec. 5	V. slight.	V. slight.	.03	7.10	.0006	.0024	.55	.2200	.0000	.07	2.6	.0070
29574	Dec. 5	Decided.	Heavy.	–	11.10	.0000	.0010	.33	.0420	.0000	.05	3.5	.0130
29575	Dec. 5	V. slight.	Slight.	.05	7.40	.0000	.0010	.39	.0980	.0000	.02	2.6	.0070
29576	Dec. 5	Decided.	Cons.	.07	8.10	.0004	.0034	.52	.1020	.0003	.08	2.9	.0200
29557	Dec. 2	None.	None.	.00	7.10	.0000	.0014	.52	.1760	.0001	.01	2.6	.0010
29578	Dec. 5	V. slight.	Slight.	.00	7.40	.0000	.0016	.53	.2300	.0002	.03	3.0	.0060

Odor, none. A faintly unpleasant odor was developed in No. 29576 on heating. —— The samples were collected from tubular test wells located about 600 feet north-east of Neponset Street, opposite the intersection of Pleasant Street.

NORWOOD.

Chemical Examination of Water from a Group of Tubular Test Wells, collected during a Pumping Test.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1900.												
29848	Jan. 2	None.	None.	.01	8.70	.0000	.0012	.60	.2600	.0000	.04	3.3	.0040
29849	Jan. 3	None.	None.	.00	8.80	.0000	.0012	.60	.2680	.0000	.02	3.3	.0110
29856	Jan. 4	None.	None.	.00	8.70	.0000	.0012	.61	.2280	.0000	.02	3.3	.0050
29857	Jan. 4	None.	None.	.00	8.20	.0000	.0012	.61	.2200	.0000	.03	3.3	.0040
29860	Jan. 5	None.	None.	.00	8.00	.0000	.0012	.64	.2600	.0000	.02	3.3	.0080
29866	Jan. 6	None.	None.	.00	8.20	.0000	.0016	.61	.2700	.0000	.03	3.3	.0040
29867	Jan. 7	None.	None.	.00	8.70	.0000	.0014	.61	.2600	.0000	.02	3.3	.0080
29868	Jan. 8	None.	None.	.00	8.50	.0000	.0014	.61	.2750	.0000	.03	3.3	.0040
29902	Jan. 10	None.	None.	.00	8.10	.0000	.0012	.56	.2400	.0000	.02	3.3	.0020
29924	Jan. 11	None.	None.	.00	8.40	.0000	.0010	.57	.1640	.0000	.02	3.3	.0040

Odor, none. —— The samples were collected from a group of five driven wells located about 600 feet north-east of Neponset Street, opposite the intersection of Pleasant Street, during a pumping test. The test was begun on Dec. 29, 1899, and water was pumped at an average rate of 343,000 gallons per day until Jan. 12, 1900.

Water Supply of Orange.

The advice of the State Board of Health to the town of Orange, relative to the cause of a taste and odor in the water of the public water supply, may be found on page 38 of this volume.

Chemical Examination of Water from the Distributing Reservoir of the Orange Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30686	Mar. 21	V. slight.	V. slight.	.08	2.20	0.70	.0004	.0082	.0070	.0012	.12	.0010	.0000	.15	0.5
31053	Apr. 20	V. slight.	V. slight.	.07	2.75	0.75	.0000	.0064	.0050	.0014	.08	.0000	.0001	.20	0.5
32149	July 25	V slight.	V. slight.	.00	4.30	1.20	.0002	.0076	.0062	.0014	.13	.0010	.0000	.10	0.6
32973	Sept. 18	V. slight.	Slight.	.10	2.90	0.85	.0002	.0120	.0072	.0048	.10	.0010	.0000	.19	0.5
34121	Dec. 17	V. slight.	V slight.	.12	3.90	1.05	.0026	.0182	.0154	.0028	.23	.0060	.0001	.28	1.0
Av...	....	....	....	.07	3.21	0.91	.0007	.0105	.0082	.0023	.13	.0018	.0000	.18	0.6

Odor of the last sample, faintly vegetable, becoming distinctly unpleasant on heating; of the others, none, generally becoming fishy or oily on heating.

Microscopical Examination.

The organism *Uroglena* was found in the samples collected in March and December.

Water Supply of Palmer Fire District. — Palmer Water Company.

Chemical Examination of Water from the Lower Reservoir of the Palmer Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
31040	Apr. 18	Slight.	Slight.	.12	2.85	1.10	.0006	.0210	.0158	.0052	.12	.0020	.0001	.26	0.3
31819	June 21	Decided.	Cons.	.28	3.65	1.00	.0004	.0194	.0164	.0030	.10	.0050	.0000	.34	0.6
32950	Sept. 17	Decided.	Slight.	.28	4.30	1.40	.0004	.0350	.0268	.0082	.20	.0020	.0002	.53	0.6
34114	Dec. 17	V. slight.	V. slight.	.19	3.05	0.85	.0018	.0096	.0088	.0008	.13	.0100	.0000	.24	0.5
Av...	....	....	....	.22	3.46	1.09	.0008	.0212	.0169	.0043	.14	.0047	.0001	.34	0.5

Odor, none, becoming faintly vegetable in the second sample on heating.

Water Supply of Peabody.

Chemical Examination of Water from Brown's Pond, Peabody.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30202	Feb. 15	Slight.	V. slight.	.12	2.95	1.10	.0018	.0150	.0140	.0010	.52	.0010	.0001	.28	0.8
31184	May 8	V. slight.	Cons.	.15	3.00	0.95	.0008	.0170	.0150	.0020	.48	.0000	.0001	.38	0.5
31714	June 15	V. slight.	Cons.	.20	3.00	1.15	.0036	.0200	.0188	.0012	.50	.0000	.0001	.40	0.6
32472	Aug. 14	V. slight.	Slight.	.13	3.20	1.20	.0008	.0210	.0162	.0048	.58	.0000	.0000	.33	0.5
33629	Nov. 12	V. slight.	V. slight.	.03	2.95	0.90	.0014	.0190	.0152	.0038	.58	.0010	.0000	.21	0.3
Av...	....	....	....	.13	3.02	1.06	.0017	.0184	.0158	.0026	.53	.0004	.0001	.32	0.5

Odor, generally vegetable or none. A fishy or oily odor was developed in the first, third and last samples on heating.

Microscopical Examination.

The organism *Uroglena* was found in the samples collected in February and November.

PEABODY.

Chemical Examination of Water from Spring Pond, Peabody.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30203	Feb. 15	Slight.	Slight.	.03	3.95	1.25	.0044	.0136	.0122	.0014	.63	.0010	.0000	.15	1.3
31185	May 8	V. slight.	Slight.	.02	3.75	0.90	.0028	.0148	.0112	.0036	.68	.0010	.0003	.21	1.6
32473	Aug. 14	V. slight.	V. slight.	.01	3.95	1.20	.0026	.0144	.0128	.0016	.70	.0000	.0000	.12	1.4
33630	Nov. 12	V. slight.	V. slight.	.03	4.25	1.10	.0088	.0146	.0134	.0012	.70	.0010	.0000	.11	1.4
Av...	....	....	....	.02	3.97	1.11	.0046	.0143	.0124	.0019	.68	.0007	.0001	.15	1.4

Odor of the first two samples, faintly vegetable, becoming stronger on heating; of the last two, none.

The advice of the State Board of Health to the board of health of Peabody, relative to the quality of the water of a well used for the supply of a public drinking fountain in that town, may be found on page 39 of this volume. The advice of the Board, relative to the quality of the water of a spring used for the supply of a small factory, may be found on page 40 of this volume. The results of analyses of samples of water from these sources are given in the following tables : —

Chemical Examination of Water from a Drinking Fountain supplied from a Spring in Peabody.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30912	Apr. 3	None.	None.	.00	26.70	.0012	.0044	2.06	1.3600	.0006	.11	8.7	.0030
31102	Apr. 27	None.	None.	.00	26.40	.0000	.0058	2.04	1.0800	.0005	.08	8.3	.0050

Odor, none.—— The samples were collected from a drinking fountain, located at the corner of Forest and Lowell streets.

PEABODY.

Chemical Examination of Water from a Spring supplying the Shoe Shop of J. H. Hammond, in Peabody.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
32760	Aug. 31	None.	V. slight.	.01	54.80	.2160	.0096	8.45	2.1000	.0140	.18	11.4	.0110

Odor, none. —— The sample was collected from the spring, which is located a short distance south of Harris Street.

PEMBROKE.

Chemical Examination of Silver Lake, in Pembroke, collected near the Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30140	Feb. 6	V. slight.	Slight.	.07	2.85	1.00	.0000	.0122	.0104	.0018	.67	.0010	.0000	.23	0.3
30926	Apr. 4	V. slight.	Slight.	.08	2.70	1.05	.0000	.0098	.0092	.0006	.63	.0020	.0000	.26	0.2
31473	June 5	V. slight.	Slight.	.11	3.05	0.90	.0010	.0136	.0128	.0008	.63	.0010	.0000	.30	0.3
32383	Aug. 6	None.	V. slight.	.10	2.55	0.85	.0002	.0106	.0102	.0004	.63	.0000	.0000	.26	0.3
33168	Oct. 2	None.	V. slight.	.09	2.85	0.60	.0006	.0116	.0104	.0012	.65	.0040	.0000	.21	0.2
33940	Dec. 4	V. slight.	Slight.	.10	2.80	0.95	.0022	.0160	.0140	.0020	.61	.0040	.0001	.24	0.5
Av...	....	....	....	.09	2.80	0.89	.0007	.0123	.0112	.0011	.64	.0020	.0000	.25	0.3

Odor, faintly vegetable or none. A vegetable odor was developed in all but one of the samples on heating. —— The samples were collected from the lake, off Gunner's Point. This lake is not used as a source of water supply.

PEMBROKE.

Chemical Examination of Water from Oldham Pond, Pembroke.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30193	Feb. 14	V. slight.	Cons.	.21	3.45	1.20	.0004	.0230	.0166	.0064	.58	.0050	.0000	.35	0.5
31188	May 8	V. slight.	V. slight.	.25	3.70	0.95	.0024	.0180	.0156	.0024	.59	.0010	.0001	.44	0.5
32519	Aug. 15	V. slight.	V. slight.	.21	3.45	0.85	.0014	.0228	.0196	.0032	.65	.0000	.0001	.37	0.5
33670	Nov. 14	V. slight.	V. slight.	.19	3.75	1.20	.0010	.0230	.0204	.0026	.65	.0010	.0000	.32	0.0
Av...	....	....	....	.21	3.59	1.05	.0013	.0217	.0180	.0037	.62	.0017	.0000	.37	0.4

Odor of the last sample, none; of the others, faintly vegetable, becoming stronger on heating.—— The samples were collected from the pond, near its outlet; this pond is not used as a source of water supply.

Water Supply of Pittsfield.

Chemical Examination of Water from Sacket Brook Reservoir, Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30796	Mar. 27	None.	V. slight.	.04	5.45	0.70	.0004	.0080	.0062	.0018	.08	.0130	.0000	.13	4.4
31872	June 26	None.	V. slight.	.02	7.25	1.25	.0036	.0088	.0084	.0004	.11	.0110	.0000	.10	6.0
32965	Sept. 18	V. slight.	V. slight.	.07	8.20	1.20	.0024	.0142	.0138	.0004	.08	.0100	.0000	.09	6.9
34174	Dec. 18	V. slight.	Slight.	.01	7.85	1.70	.0048	.0310	.0252	.0058	.12	.0210	.0000	.11	6.1
Av...	....	....	....	.03	7.19	1.21	.0028	.0155	.0134	.0021	.10	.0137	.0000	.11	5.8

Odor of the second sample, faintly vegetable; of the others, none.

PITTSFIELD.

Chemical Examination of Water from Sacket Brook in the Vicinity of the Pumping Station of the Pittsfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30797	Mar. 27	None.	V. slight.	.03	6.90	1.10	.0004	.0034	.0034	.0000	.10	.0180	.0000	.11	6.1
31873	June 26	None.	Slight.	.02	10.00	1.75	.0064	.0096	.0060	.0036	.10	.0130	.0000	.07	9.4
32966	Sept. 18	V. slight.	V. slight.	.08	12.00	2.25	.0006	.0256	.0240	.0016	.10	.0080	.0000	.12	9.9
34175	Dec. 18	V. slight.	Cons.	.00	12.95	2.05	.0010	.0376	.0124	.0252	.12	.0310	.0000	.07	12.3
Av...	....	....	....	.03	10.46	1.79	.0021	.0190	.0114	.0076	.10	.0175	.0000	.09	9.4

Odor of the first and last samples, none; of the second, faintly vegetable; of the third, none, becoming distinctly vegetable on heating.

Chemical Examination of Water from Ashley Brook Reservoir, Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30793	Mar. 27	V. slight.	V. slight.	.09	5.00	1.30	.0008	.0124	.0122	.0002	.11	.0090	.0000	.24	3.9
31869	June 26	V. slight.	V. slight.	.06	6.65	1.85	.0074	.0170	.0160	.0010	.12	.0070	.0000	.25	4.4
32962	Sept. 18	V slight.	V. slight.	.15	4.70	1.40	.0004	.0212	.0204	.0008	.07	.0020	.0000	.26	3.0
34171	Dec. 18	V. slight	V. slight	.03	7.50	1.55	.0032	.0156	.0142	.0014	.10	.0200	.0001	.12	6.4
Av...	....	....	....	.08	5.96	1.52	.0029	.0165	.0157	.0008	.10	.0095	.0000	.22	4.4

Odor, none, becoming faintly vegetable in the second sample on heating.

PITTSFIELD.

Chemical Examination of Water from Hathaway Brook Reservoir, Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30794	Mar. 27	None.	V. slight.	.01	7.10	1.40	.0012	.0120	.0114	.0006	.13	.0130	.0000	.11	6.0
31870	June 26	None.	V. slight.	.02	10.30	2.15	.0006	.0038	.0036	.0002	.08	.0140	.0000	.10	8.9
32963	Sept. 18	V. slight.	V. slight.	.02	10.25	1.60	.0000	.0128	.0124	.0004	.13	.0090	.0000	.06	8.9
34172	Dec. 18	None.	V. slight.	.00	7.85	1.65	.0012	.0070	.0062	.0008	.14	.0240	.0000	.10	7.3
Av...	....	....	....	.01	8.87	1.70	.0007	.0089	.0084	.0005	.12	.0150	.0000	.09	7.8

Odor, none.

Chemical Examination of Water from Mill Brook Reservoir, Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30795	Mar. 27	None.	V. slight.	.00	4.50	0.60	.0000	.0028	.0028	.0000	.08	.0040	.0000	.09	3.3
31871	June 26	None.	Cons.	.01	5.65	0.90	.0022	.0102	.0042	.0060	.08	.0010	.0000	.09	4.0
32964	Sept. 18	None.	None.	.01	6.10	0.65	.0000	.0026	.0024	.0002	.07	.0070	.0000	.05	5.1
34173	Dec. 18	V. slight.	Slight.	.01	5.15	1.00	.0024	.0224	.0182	.0042	.12	.0110	.0002	.10	3.6
Av...	....	....	....	.01	5.35	0.79	.0011	.0095	.0069	.0026	.09	.0057	.0000	.08	4.0

Odor of the second sample, faintly vegetable; of the others, none, becoming faintly unpleasant in the last sample on heating.

Water Supply of Plymouth.

Chemical Examination of Water from Little South Pond, Plymouth.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
29882	Jan. 9	V. slight.	V. slight.	.00	2.75	0.75	.0010	.0164	.0148	.0016	.81	.0030	.0000	.15	0.2
30183	Feb. 13	None.	V. slight.	.01	2.60	1.10	.0018	.0144	.0126	.0018	.70	.0030	.0000	.12	0.2
30448	Mar. 12	V. slight.	V. slight.	.01	2.35	0.65	.0014	.0120	.0114	.0006	.66	.0010	.0000	.12	0.0
30949	Apr. 10	None.	V. slight.	.00	2.75	0.80	.0010	.0114	.0108	.0006	.68	.0000	.0000	.14	0.0
31183	May 8	None.	Slight.	.00	2.30	0.50	.0006	.0136	.0116	.0020	.71	.0010	.0000	.09	0.0
31508	June 11	None.	V. slight.	.00	2.75	0.90	.0010	.0144	.0130	.0014	.69	.0010	.0000	.15	0.0
31971	July 10	V. slight	Slight.	.01	2.40	0.60	.0000	.0138	.0128	.0010	.67	.0020	.0000	.13	0.0
32475	Aug. 14	V. slight.	V. slight.	.01	2.50	0.50	.0010	.0204	.0164	.0040	.73	.0000	.0000	.09	0.0
32863	Sept. 11	V. slight.	Slight.	.01	2.60	0.70	.0002	.0186	.0170	.0016	.76	.0000	.0000	.12	0.0
33234	Oct. 9	V. slight.	Slight.	.02	2.60	0.65	.0020	.0204	.0164	.0040	.75	.0010	.0000	.14	0.0
33716	Nov. 20	None.	V. slight.	.00	2.85	0.90	.0020	.0178	.0152	.0026	.74	.0010	.0000	.12	0.0
34127	Dec. 18	None.	V. slight.	.00	2.75	0.60	.0006	.0160	.0142	.0018	.74	.0020	.0000	.13	0.0
Av...	....	....	....	.01	2.60	0.72	.0010	.0158	.0139	.0019	.72	.0012	.0000	.12	0.0

Odor of the first sample, faintly vegetable; of the others, none, occasionally becoming unpleasant, and in August faintly fishy, on heating.

Microscopical Examination.

The organism *Uroglena* was found in the samples collected in January and May.

The advice of the State Board of Health to the board of health of Plymouth, relative to the quality of the water of "Elder Brewster" spring, in Plymouth, used by the public for drinking purposes, may be found on page 91 of this volume. The results of analyses of samples of water from the spring are given in the following table: —

Chemical Examination of Water from Elder Brewster Spring in Plymouth.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1900.												
31563	June 12	None.	None.	.00	6.70	.0000	.0004	1.25	.1100	.0000	.00	1.3	.0030
31833	June 23	None.	V. slight.	.00	6.30	.0002	.0010	1.19	.0920	.0000	.04	2.0	.0040
31834	June 23	None.	None.	.00	6.60	.0006	.0008	1.20	.0920	.0001	.03	1.7	.0010
31951	July 7	None.	None.	.00	6.40	.0002	.0002	1.23	.1140	.0000	.00	1.6	.0020
32439	Aug. 9	None.	None.	.00	6.40	.0000	.0002	1.20	.0800	.0000	.02	1.3	.0030

Odor, none. —— The second sample was collected from the spring; the others from a public drinking fountain on Leyden Street, supplied from the spring.

PROVINCETOWN.

Water Supply of Provincetown.

Chemical Examination of Water from the Open Basin of Provincetown Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1900.												
29859	Jan. 4	Decided.	Cons.	–	11.30	.0098	.0164	2.80	.0220	.0002	.64	2.7	.1700
30138	Feb. 6	Decided.	Heavy	–	10.80	.0104	.0188	2.88	.0070	.0001	.78	2.3	.4800
30388	Mar. 6	Decided.	Cons.	–	11.30	.0300	.0156	2.65	.0020	.0001	.68	3.1	.6000
30928	Apr. 4	Decided.	Cons.	–	10.80	.0228	.0126	2.62	.0020	.0000	.68	3.0	.3840
31145	May 1	Decided.	Heavy.	–	11.50	.0196	.0150	2.68	.0030	.0000	.80	3.0	.4200
31485	June 6	Decided.	Cons.	–	10.30	.0054	.0146	2.78	.0100	.0000	.62	2.6	.3040
31930	July 2	Decided.	Heavy.	–	10.50	.0100	.0122	2.69	.0030	.0000	.65	2.2	.3520
32387	Aug. 6	Slight.	V. slight.	–	9.80	.0022	.0146	2.79	.0140	.0001	.57	2.0	.1150
32839	Sept. 5	Slight.	Slight.	–	9.70	.0057	.0185	2.64	.0160	.0001	.64	2.2	.1160
33180	Oct. 3	Decided.	Cons.	–	11.00	.0072	.0174	2.69	.0040	.0001	.65	2.0	.4080
33610	Nov. 7	Decided.	Cons.	–	12.30	.0226	.0212	2.66	.0050	.0002	.81	2.9	.7400
33954	Dec. 5	Decided.	Heavy.	–	11.40	.0206	.0242	2.62	.0050	.0004	.85	2.9	.4400

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
–	1898	–	–	0.66	9.42	.0054	.0151	2.50	.0047	.0001	.62	2.1	.2289
–	1899	–	–	1.18	10.97	.0159	.0194	2.58	.0048	.0001	.77	2.8	.4433
–	1900	–	–	0.91	10.89	.0139	.0168	2.71	.0077	.0001	.70	2.6	.3774

Note to analyses of 1900: Odor of No. 32839, distinctly earthy; of the others, none, sometimes becoming faintly earthy on heating.

Water Supply of Quincy.

(See *Metropolitan Water District*, pages 109–128.)

Water Supply of Randolph and Holbrook.

Chemical Examination of Water from Great Pond in Randolph and Braintree.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
29899	Jan. 9	V. slight.	V. slight.	.29	4.45	1.70	.0020	.0174	.0170	.0004	.53	.0030	.0001	.52	1.0
30199	Feb. 14	V. slight.	V. slight.	.37	4.00	1.45	.0006	.0166	.0162	.0004	.47	.0040	.0001	.58	1.0
30455	Mar. 13	V. slight.	V. slight.	.40	3.15	1.20	.0002	.0148	.0136	.0012	.42	.0020	.0000	.52	0.5
30951	Apr. 10	V. slight.	V. slight.	.35	3.00	1.00	.0004	.0130	.0130	.0000	.43	.0010	.0000	.52	0.8
31182	May 8	V. slight.	None.	.46	3.65	1.50	.0004	.0168	.0162	.0006	.44	.0010	.0000	.58	0.6
31532	June 12	Slight.	Slight.	.55	3.80	1.35	.0014	.0222	.0204	.0018	.45	.0010	.0001	.59	0.5
31972	July 10	V. slight.	V. slight.	.45	3.45	1.35	.0012	.0222	.0206	.0016	.45	.0040	.0000	.59	0.6
32476	Aug. 14	Slight.	Slight.	.30	3.80	1.15	.0010	.0224	.0204	.0020	.49	.0000	.0000	.56	1.4
32876	Sept. 11	Slight.	Slight.	.25	3.75	1.20	.0004	.0220	.0200	.0020	.48	.0010	.0000	.48	0.6
33249	Oct. 9	V. slight.	Slight.	.21	3.45	1.30	.0012	.0160	.0148	.0012	.50	.0010	.0000	.40	1.0
33653	Nov. 13	V. slight.	V. slight.	.20	4.00	1.35	.0012	.0174	.0168	.0006	.53	.0020	.0000	.43	1.0
34012	Dec. 11	None.	None.	.41	4.30	1.55	.0024	.0204	.0186	.0018	.63	.0040	.0000	.61	1.3
Av.	....	....	....	.35	3.73	1.34	.0010	.0184	.0173	.0011	.48	.0020	.0000	.53	0.9

Odor, vegetable or none.—— No. 33249 was collected from a tap in Holbrook; the others, from a tap at the pumping station.

Water Supply of Reading.

Chemical Examination of Water from the Filter-gallery of the Reading Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1900.												
29894	Jan. 9	Decided.	Cons.	.39	9.60	.0110	.0064	.54	.0040	.0001	.33	3.3	.3900
30220	Feb. 16	Decided.	Cons.	.29	10.60	.0114	.0088	.46	.0050	.0001	.33	3.3	.2300
30446	Mar. 13	Decided	Cons.	.44	9.40	.0096	.0104	.42	.0030	.0000	.37	3.4	.3700
30938	Apr. 9	Decided.	Cons.	–	8.30	.0078	.0086	.42	.0040	.0000	.40	2.5	.1760
31170	May 7	Decided.	Cons.	–	8.40	.0082	.0116	.38	.0030	.0000	.54	2.7	.1600
31526	June 11	Decided.	Cons.	.80	9.00	.0104	.0164	.43	.0030	.0001	.79	2.6	.1450
31963	July 9	Decided.	Cons.	.71	8.00	.0094	.0106	.39	.0060	.0000	.54	2.1	.1050
32447	Aug. 10	Decided.	Cons.	.60	7.50	.0090	.0064	.50	.0040	.0000	.36	1.8	.1700
32871	Sept. 11	Decided.	Cons.	.70	6.90	.0104	.0076	.47	.0020	.0000	.31	2.0	.2200
33219	Oct. 8	Decided.	Cons.	.82	8.70	.0104	.0082	.52	.0020	.0000	.38	2.2	.3800
33618	Nov. 12	Decided.	Cons.	–	10.80	.0124	.0108	.49	.0010	.0000	.45	3.4	.3200
33993	Dec. 10	Decided.	Heavy.	–	14.10	.0162	.0122	.44	.0120	.0001	.39	5.7	.3300

Averages by Years.

–	1891	–	–	.13	12.96	.0016	.0063	.43	.0094	.0001	–	5.1	–
–	1892	–	–	.44	9.25	.0042	.0073	.54	.0071	.0001	–	3.4	–
–	1893	–	–	.64	10.08	.0034	.0087	.56	.0032	.0001	.35	3.9	.1251
–	1894	–	–	.45	12.76	.0043	.0107	.68	.0029	.0000	.35	5.0	.2642
–	1895	–	–	.61	13.88	.0088	.0114	.72	.0048	.0000	.44	5.5	.2277
–	1896	–	–	.52	11.50	.0080	.0089	.51	.0059	.0001	.40	4.1	.2696
–	1897	–	–	.76	11.12	.0090	.0110	.53	.0058	.0001	.44	4.0	.2644
–	1898	–	–	.82	9.61	.0095	.0141	.44	.0003	.0000	.64	3.0	.2254
–	1899	–	–	.67	7.80	.0099	.0109	.44	.0025	.0000	.50	2.4	.1721
–	1900	–	–	.59	9.27	.0105	.0098	.45	.0041	.0000	.43	2.9	.2497

Note to analyses of 1900: Odor, generally none, occasionally faintly earthy.

READING.

Chemical Examination of Water from Reading Filter-gallery after passing through the Mechanical Filter.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1900.												
29895	Jan. 9	None.	None.	.05	15.30	.0058	.0060	.50	.0060	.0020	.20	7.9	.0020
30221	Feb. 16	None.	None.	.08	14.70	.0050	.0058	.47	.0080	.0012	.20	7.4	.0060
30447	Mar. 13	None.	None.	.09	14.30	.0052	.0058	.47	.0060	.0011	.19	7.9	.0020
30939	Apr. 9	None.	None.	.06	12.50	.0048	.0056	.41	.0060	.0006	.19	6.7	.0020
31171	May 7	V. slight.	None.	.17	14.10	.0032	.0094	.42	.0050	.0009	.31	7.9	.0180
31527	June 11	V. slight.	None.	.34	16.00	.0082	.0122	.45	.0030	.0009	.45	9.0	.0130
31964	July 9	V. slight.	None.	.24	14.50	.0064	.0080	.42	.0020	.0014	.35	8.6	.0080
32448	Aug. 10	V. slight.	None.	.20	13.60	.0050	.0046	.52	.0000	.0023	.27	7.1	.0190
32872	Sept. 11	None.	None.	.11	11.70	.0050	.0056	.50	.0020	.0024	.19	5.7	.0020
33220	Oct. 8	None.	None.	.10	13.40	.0044	.0064	.52	.0020	.0018	.20	7.0	.0050
33619	Nov. 12	None.	None.	.16	16.40	.0040	.0096	.50	.0020	.0016	.26	8.6	.0170
33994	Dec. 10	None.	None.	.10	18.60	.0070	.0090	.48	.0130	.0014	.25	10.5	.0040

Averages by Years.

-	1896	-	-	.15	19.42	.0035	.0067	.56	.0043	.0016	.24	11.3	.0091
-	1897	-	-	.23	18.54	.0034	.0084	.52	.0082	.0010	.29	12.7	.0037
-	1898	-	-	.27	16.82	.0028	.0103	.45	.0060	.0006	.34	10.0	.0132
-	1899	-	-	.23	14.60	.0040	.0080	.45	.0042	.0016	.32	8.4	.0084
-	1900	-	-	.14	14.59	.0053	.0073	.47	.0046	.0015	.25	7.9	.0082

NOTE to analyses of 1900: Odor of No. 31527, distinctly earthy; of the others, none.

WATER SUPPLY OF REVERE.

(See *Metropolitan Water District*, pages 109–128.)

WATER SUPPLY OF ROCKLAND.

(See *Abington*.)

WATER SUPPLY OF ROCKPORT.

Chemical Examination of Water from Cape Pond, Rockport.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
29905	Jan. 10	Slight.	Cons.	.23	11.05	2.65	.0020	.0360	.0186	.0174	4.58	.0030	.0000	.33	1.0
30236	Feb. 19	Slight.	Cons.	.25	9.25	1.65	.0002	.0254	.0218	.0036	3.69	.0010	.0000	.34	0.5
30632	Mar. 19	V. slight.	Cons.	.22	9.15	1.85	.0004	.0204	.0158	.0046	3.78	.0010	.0000	.32	1.0
31018	Apr. 16	V. slight.	Slight.	.13	9.15	1.70	.0000	.0204	.0182	.0022	3.98	.0010	.0000	.27	1.3
31242	May 14	Slight.	Cons.	.20	8.90	1.40	.0028	.0316	.0184	.0132	4.13	.0010	.0000	.30	1.3
31777	June 18	Slight.	Cons.	.20	9.80	1.65	.0138	.0314	.0222	.0092	4.07	.0010	.0001	.36	1.0
32307	July 30	Decided.	Heavy.	.09	9.35	1.15	.0008	.0556	.0188	.0368	4.11	.0000	.0001	.38	1.0
32780	Sept. 3	Decided.	Cons.	.10	10.25	1.75	.0004	.0356	.0244	.0112	4.27	.0020	.0000	.32	0.8
33055	Sept. 24	Decided.	Cons.	.14	10.30	1.30	.0004	.0584	.0232	.0352	4.16	.0020	.0000	.32	1.1
33525	Oct. 30	Decided.	Cons.	.19	9.80	1.70	.0048	.0380	.0222	.0158	4.08	.0030	.0000	.39	1.1
33921	Dec. 3	Decided.	Cons.	.20	9.50	1.80	.0006	.0284	.0218	.0066	4.08	.0020	.0000	.36	1.3
34185	Dec. 19	Decided.	Cons.	.12	10.55	1.90	.0038	.0310	.0218	.0092	4.35	.0040	.0000	.34	1.3

Averages by Years.

-	1894	-	-	.22	12.85	1.91	.0001	.0225	.0163	.0062	5.55	.0010	.0000	.25	1.3
-	1895	-	-	.25	12.61	2.31	.0025	.0302	.0198	.0104	5.42	.0037	.0000	.32	1.2
-	1896	-	-	.29	11.67	2.11	.0008	.0198	.0149	.0049	4.97	.0039	.0000	.24	1.0
-	1897	-	-	.30	10.94	2.10	.0034	.0251	.0196	.0055	4.60	.0058	.0000	.31	1.1
-	1898	-	-	.44	10.43	2.17	.0049	.0336	.0231	.0105	4.34	.0025	.0001	.38	1.0
-	1899	-	-	.35	10.21	2.06	.0040	.0308	.0230	.0078	4.24	.0043	.0001	.39	0.8
-	1900	-	-	.17	9.75	1.71	.0025	.0343	.0206	.0137	4.11	.0017	.0000	.34	1.1

NOTE to analyses of 1900: Odor of No. 31018, none; of the others, vegetable or unpleasant. A fishy odor was developed in the March sample on heating.—No. 29905 was collected from the pond; the others, from a faucet at the pumping station.

Microscopical Examination of Water from Cape Pond, Rockport.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	Aug.	Sept.	Sept.	Nov.	Dec.	Dec.
Day of examination,	10	20	20	17	15	20	1	4	25	1	5	21
Number of sample,	29905	30236	30632	31018	31242	31777	32307	32780	33055	33525	33921	34185
PLANTS.												
Diatomaceæ,	298	1,561	4,800	6,690	4,392	1,995	512	659	14,640	2,930	430	514
Asterionella,	282	1,548	4,800	6,400	2,356	63	4	0	0	0	248	503
Melosira,	14	12	0	288	2,036	1,932	506	656	14,640	2,928	160	9
Cyanophyceæ,	1,144	36	1	2	292	191	84	0	0	6	1	0
Anabæna,	1,144	36	1	0	292	191	84	0	0	0	1	0
Algæ,	18	4	4	18	4	37	36	31	20	10	14	42

ROCKPORT.

Microscopical Examination of Water from Cape Pond, Rockport — Concluded.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	Aug.	Sept.	Sept.	Nov.	Dec.	Dec.
ANIMALS.												
Infusoria,	306	285	19	30	52	5	10	42	448	70	6	0
Dinobryon,	268	266	7	26	32	0	0	0	0	0	0	0
Euglena,	0	4	0	0	8	0	4	0	0	34	1	0
Peridinium,	36	8	10	2	0	0	0	32	364	0	1	0
Trachelomonas,	0	4	2	2	12	5	2	10	84	36	4	0
Vermes,	0	0	0	2	0	0	0	1	2	0	1	2
Crustacea, Cyclops,	0	pr.	0	0	0	0	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	6	10	3	10	40	20	40	15	14	14	10	3
TOTAL,	1,772	1,896	4,827	6,752	4,780	2,248	682	748	15,124	3,030	462	561

WATER SUPPLY OF RUTLAND.

Chemical Examination of Water from Muschopauge Lake, Rutland, collected near the Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30135	Jan. 31	V. slight.	V. slight.	.02	1.75	0.95	.0098	.0118	.0114	.0004	.16	.0010	.0001	.15	0.5
32489	Aug. 14	V. slight.	V. slight.	.01	1.70	0.40	.0010	.0188	.0148	.0040	.14	.0000	.0000	.15	0.2
33136	Sept. 26	V. slight.	Slight.	.02	2.10	0.75	.0044	.0130	.0118	.0012	.14	.0020	.0000	.15	0.3
34204	Dec. 20	V. slight.	V. slight.	.02	2.90	0.85	.0070	.0218	.0186	.0032	.28	.0030	.0001	.16	0.5
Av.	....	....	....	.02	2.11	0.74	.0055	.0163	.0141	.0022	.18	.0015	.0000	.15	0.4

Odor, none, becoming generally faintly vegetable on heating.

Water Supply of Salem and Beverly.

Chemical Examination of Water from Wenham Lake in Beverly and Wenham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29885	Jan. 9	V. slight.	Slight.	.10	5.85	1.35	.0004	.0152	.0138	.0014	.82	.0080	.0001	.22	2.6
30174	Feb. 13	Slight.	Slight.	.10	5.60	1.65	.0066	.0176	.0138	.0038	.70	.0070	.0001	.26	2.3
30432	Mar. 9	Slight.	Cons.	.15	5.15	1.60	.0032	.0172	.0138	.0034	.67	.0060	.0001	.32	2.2
30799	Mar. 26	V. slight.	V. slight.	.15	4.85	1.35	.0018	.0152	.0144	.0008	.68	.0060	.0001	.31	2.1
30983	Apr. 10	V. slight.	V. slight.	.12	4.70	1.45	.0008	.0148	.0140	.0008	.67	.0040	.0001	.39	2.1
32874	Sept. 11	V. slight.	Slight.	.10	4.75	1.10	.0010	.0208	.0162	.0046	.78	.0040	.0000	.27	2.1
33255	Oct. 10	Slight.	Heavy.	.11	5.30	1.15	.0036	.0292	.0150	.0142	.78	.0010	.0000	.21	2.2
33645	Nov. 13	V. slight.	V. slight.	.05	5.75	1.15	.0220	.0172	.0140	.0032	.79	.0060	.0004	.22	2.2
34015	Dec. 11	V. slight.	Slight.	.10	5.55	1.25	.0106	.0184	.0154	.0030	.74	.0080	.0003	.21	2.3

Averages by Years.

-	1888	-	-	.05	4.67	0.97	.0020	.0146	-	-	.73	.0058	.0001	-	-
-	1889	-	-	.06	4.23	1.05	.0014	.0173	.0138	.0035	.72	.0052	.0002	-	-
-	1890	-	-	.05	4.57	0.90	.0016	.0154	.0125	.0029	.74	.0104	.0001	-	2.5
-	1891	-	-	.07	4.70	1.12	.0006	.0147	.0113	.0034	.72	.0125	.0000	-	1.9
-	1892	-	-	.03	4.85	1.10	.0016	.0137	.0103	.0034	.75	.0077	.0000	-	2.2
-	1893	-	-	.04	5.49	1.26	.0033	.0130	.0100	.0030	.77	.0055	.0001	.16	2.6
-	1894	-	-	.07	6.69	1.53	.0030	.0148	.0114	.0034	.82	.0023	.0001	.14	3.0
-	1895	-	-	.21	6.75	1.97	.0026	.0177	.0146	.0031	.81	.0059	.0001	.30	3.1
-	1896	-	-	.15	6.30	1.82	.0020	.0213	.0152	.0061	.80	.0053	.0001	.28	2.7
-	1897	-	-	.13	6.09	1.60	.0027	.0206	.0170	.0036	.82	.0048	.0001	.29	2.7
-	1898	-	-	.15	5.61	1.73	.0025	.0181	.0151	.0030	.80	.0040	.0001	.29	2.3
-	1899	-	-	.13	5.37	1.70	.0043	.0184	.0155	.0029	.73	.0069	.0002	.27	2.1
-	1900*	-	-	.10	5.31	1.32	.0059	.0187	.0145	.0042	.74	.0055	.0001	.26	2.2

NOTE to analyses of 1900: Odor of No. 30432, faintly unpleasant; of the others, vegetable or none. —— The first four and the last samples were collected from a faucet at the pumping station; the others, from the lake.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

SALEM AND BEVERLY.

Microscopical Examination of Water from Wenham Lake in Beverly and Wenham.

[Number of organisms per cubic centimeter.]

	1900.								
	Jan.	Feb.	Mar.	Mar.	Apr.	Sept.	Oct.	Nov.	Dec.
Day of examination,	10	14	10	28	12	11	11	14	12
Number of sample,	29885	30174	30432	30799	30983	32874	33255	33645	34015
PLANTS.									
Diatomaceæ,	836	2,432	2,278	829	936	272	150	664	1,958
Asterionella,	560	1,860	1,990	704	478	52	18	14	622
Cyclotella,	50	88	65	27	86	5	1	18	46
Fragilaria,	0	0	5	0	4	141	0	0	58
Melosira,	36	144	33	25	84	0	17	531	992
Tabellaria,	188	340	185	72	280	72	109	96	230
Cyanophyceæ,	0	0	0	0	0	35	250	5	0
Anabæna,	0	0	0	0	0	29	220	0	0
Aphanizomenon,	0	0	0	0	0	0	27	0	0
Algæ,	76	40	12	60	13	95	2	20	2
Protococcus,	74	40	12	60	13	92	0	16	0
ANIMALS.									
Infusoria,	0	4	0	0	2	0	1	15	2
Mallomonas,	0	0	0	0	0	0	1	12	0
Uroglena,	0	0	0	0	0	0	0	1	0
Vermes,	0	4	1	1	0	1	0	0	2
Crustacea, Cyclops,	0	0	0	0	0	0	0	0	pr.
Miscellaneous, Zoöglœa,	3	6	6	5	5	5	10	5	3
TOTAL,	915	2,486	2,297	895	956	408	413	709	1,967

Chemical Examination of Water from Longham Brook in Beverly and Wenham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30127	Feb. 6	Decided.	Slight.	0.80	5.55	2.65	.0176	.0412	.0360	.0052	0.68	.0080	.0002	0.98	1.0
30173	Feb. 13	Decided.	Cons.	0.34	3.65	1.50	.0068	.0288	.0204	.0084	0.37	.0070	.0001	0.46	1.1
30431	Mar. 9	Slight.	Slight.	0.45	3.90	1.80	.0010	.0208	.0180	.0028	0.65	.0010	.0001	0.62	2.0
30798	Mar. 26	Slight.	Slight.	0.45	3.90	1.40	.0046	.0300	.0230	.0070	0.67	.0020	.0001	0.65	1.0
30982	Apr. 10	V. slight.	Slight.	0.62	4.95	1.95	.0112	.0186	.0174	.0012	0.72	.0070	.0001	0.69	1.3
32873	Sept. 11	Slight.	Slight.	0.39	7.90	1.50	.0042	.0148	.0118	.0030	0.99	.0540	.0005	0.24	3.0
33254	Oct. 10	V. slight.	Cons.	0.41	8.35	1.50	.0022	.0194	.0182	.0012	1.07	.0100	.0000	0.42	2.9
33644	Nov. 13	Slight.	Slight.	0.90	8.00	2.60	.0016	.0296	.0264	.0032	1.10	.0160	.0001	1.11	2.1
34014	Dec. 11	None.	V. slight.	1.10	5.20	1.10	.0020	.0246	.0232	.0014	1.04	.0110	.0001	1.25	2.2
Av*	....	....	....	0.63	6.13	1.76	.0052	.0239	.0208	.0031	0.87	.0153	.0001	0.72	2.0

Odor, vegetable, generally becoming stronger on heating. —— The samples were collected from the brook, at lower end of the Longham Reservoir. During the greater part of the year there was no water in the reservoir.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Water Supply of Saugus.

(See *Lynn.*)

Water Supply of Sharon.

Chemical Examination of Water from the Well of the Sharon Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1900.												
30022	Jan. 23	None.	None.	.00	8.60	.0000	.0016	1.16	.2600	.0000	.01	3.0	.0020
30738	Mar. 27	None.	None.	.00	8.90	.0002	.0010	1.11	.2650	.0000	.03	2.9	.0030
31366	May 23	None.	None.	.00	8.20	.0002	.0008	1.12	.2880	.0000	.04	3.3	.0050
32335	July 31	None.	V. slight.	.00	9.80	.0000	.0010	1.05	.2100	.0000	.03	3.1	.0050
33077	Sept. 25	None.	None.	.00	10.10	.0006	.0006	1.12	.2800	.0000	.00	3.0	.0050
33826	Nov. 27	None.	None.	.00	8.90	.0004	.0008	1.23	.2750	.0000	.01	3.3	.0040
Av...	....	....	....	.00	9.08	.0002	.0010	1.13	.2630	.0000	.02	3.1	.0040

Odor, none.

Water Supply of Sheffield. — Sheffield Water Company.

Chemical Examination of Water from a Faucet in Sheffield, supplied from the Works of the Sheffield Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
32831	Sept. 5	V. slight.	None.	.01	3.80	0.50	.0004	.0004	.0004	.0000	.06	.0070	.0000	.00	2.2

Odor, none.

Water Supply of Somerville.

(See *Metropolitan Water District*, pages 109–128.)

SOUTHBOROUGH.

Water Supply of St. Mark's School, Southborough.

The advice of the State Board of Health to the St. Mark's School, at Southborough, relative to the quality of the water supply of the school, may be found on page 40 of this volume. The results of an analysis of a sample of water collected from the well from which the supply is taken are given in the following table: —

Chemical Examination of Water from a Well at St. Mark's School, Southborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1900.												
31849	June 25	None.	None.	.00	6.60	.0004	.0024	.22	.0150	.0001	.01	3.0	.0010

Odor, none. —— The sample was collected from a faucet at the pumping station.

Water Supply of Southbridge. — Southbridge Water Company.

Chemical Examination of Water from the Hatchet Brook Reservoir of the Southbridge Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30450	Mar. 13	V. slight.	V. slight.	.20	2.35	0.85	.0010	.0140	.0112	.0028	.12	.0010	.0000	.35	0.3
31559	June 12	Slight.	None.	.38	2.80	1.55	.0012	.0178	.0170	.0008	.13	.0010	.0000	.53	0.3
32951	Sept. 17	Decided.	Cons.	.30	3.00	0.90	.0004	.0316	.0176	.0140	.14	.0010	.0000	.57	0.3
34169	Dec. 19	V. slight.	V. slight.	.38	6.65	3.50	.0044	.0178	.0142	.0036	.22	.0050	.0000	.64	0.6
Av...	....	....	....	.31	3.70	1.70	.0017	.0203	.0150	.0053	.15	.0020	.0000	.52	0.4

Odor of the first sample, faintly unpleasant; of the second, none, becoming distinctly vegetable on heating; of the third, none, becoming very faintly unpleasant on heating; of the last, distinctly vegetable.

SOUTHBRIDGE.

Water Supply of American Optical Company, Southbridge.

The advice of the State Board of Health to the American Optical Company of Southbridge, relative to the quality of the water of certain wells used as sources of water supply for their factory, may be found on page 41 of this volume. The results of analyses of samples of water collected from the wells are given in the following table: —

Chemical Examination of Water from the Wells at the Works of the American Optical Company, Southbridge.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
32577	Aug. 20	None.	None.	.00	4.40	.0002	.0050	.24	.0070	.0002	.17	2.0	.0040
32578	Aug 20	V. slight.	Cons.	.06	9.90	.0166	.0016	.90	.2100	.0001	.05	4.0	.0430

Odor, unpleasant. —— The first sample was collected from a tubular well beneath the factory on Mechanics Street; the last, from a tubular well beneath the factory at Lensdale.

Water Supply of Dexter Harrington & Son, Southbridge.

The advice of the State Board of Health to Dexter Harrington & Son of Southbridge, relative to the quality of the water used by the operatives in their factory, may be found on page 41 of this volume. The results of an analysis of a sample of water collected from the well are given in the following table: —

Chemical Examination of Water from a Well at the Factory of Dexter Harrington & Son, Southbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid		Nitrates.	Nitrites.			
	1900.												
32488	Aug. 14	V. slight.	Slight.	.08	4.40	.0002	.0034	.35	.0100	.0000	.05	1.4	.0450

Odor, none.

SOUTH HADLEY.

Water Supply of South Hadley Falls Fire District, South Hadley.

Chemical Examination of Water from Leaping Well Reservoir, South Hadley.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29911	Jan. 6	V. slight.	V. slight.	.02	2.40	0.85	.0036	.0096	.0066	.0030	.12	.0020	.0000	.12	0.5
32450	Aug. 11	V. slight.	Slight.	.03	2.55	0.80	.0004	.0142	.0090	.0052	.11	.0000	.0000	.17	0.3
33467	Oct. 26	V. slight.	V. slight.	.08	2.95	0.90	.0004	.0114	.0096	.0018	.10	.0020	.0000	.11	0.3
Av...	....	....	....	.04	2.63	0.85	.0015	.0117	.0084	.0033	.11	.0013	.0000	.13	0.4

Odor of the first sample, none, becoming faintly vegetable on heating; of the others, faintly vegetable, becoming stronger on heating.

Chemical Examination of Water from Buttery Brook Reservoir, South Hadley.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
31138	Apr. 28	V. slight.	Cons.	.13	3.80	0.95	.0014	.0148	.0078	.0070	.24	.0130	.0003	.20	0.8

Odor, none, becoming very faintly vegetable on heating.

Water Supply of Spencer.

Chemical Examination of Water from Shaw Pond, Spencer.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30369	Mar. 5	V. slight.	V. slight.	.05	2.20	0.80	.0038	.0156	.0148	.0008	.15	.0120	.0000	.17	0.5
31334	May 22	V. slight.	V. slight.	.01	2.20	0.85	.0006	.0116	.0108	.0008	.18	.0050	.0000	.13	0.3
32684	Aug. 28	V. slight.	Slight.	.05	2.55	0.90	.0006	.0188	.0174	.0014	.16	.0070	.0000	.18	0.5
33924	Dec. 4	V. slight.	None.	.02	1.95	0.50	.0022	.0132	.0128	.0004	.15	.0120	.0000	.10	0.6
Av...	....	....	....	.03	2.22	0.76	.0018	.0148	.0139	.0009	.16	.0090	.0000	.14	0.5

Odor, none, becoming faintly vegetable in the second and third samples on heating.

Water Supply of Springfield and Ludlow.

The advice of the State Board of Health to the city of Springfield, relative to an additional water supply for that city and to the improvement of the present sources of supply, may be found on page 42 of this volume.

Chemical Examination of Water from Ludlow Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
31229	May 11	V. slight	Slight.	.23	2.65	1.05	.0006	.0144	.0136	.0008	.10	.0000	.0001	.40	0.5
31516	June 11	V. slight.	V. slight.	.30	2.65	1.10	.0002	.0176	.0154	.0022	.12	.0010	.0000	.42	0.5
31956	July 9	Slight.	Cons.	.54	3.15	1.25	.0002	.0266	.0188	.0078	.11	.0020	.0000	.44	0.8
32079	July 18	Slight.	Cons.	.57	3.15	1.20	.0016	.0276	.0216	.0060	.10	.0010	.0000	.48	0.8
32293	July 30	Slight.	Cons.	.70	3.00	1.30	.0004	.0306	.0242	.0064	.10	.0000	.0000	.54	0.8
32471	Aug. 14	Slight.	Cons.	.69	3.50	1.55	.0012	.0312	.0256	.0056	.12	.0010	.0000	.52	0.8
32870	Sept. 11	Decided.	Cons.	.52	3.05	1.15	.0120	.0280	.0236	.0044	.11	.0000	.0000	.42	0.8
33012	Sept. 20	Decided.	Cons.	.45	4.00	1.55	.0010	.0620	.0242	.0378	.14	.0020	.0000	.43	1.0
33068	Sept. 25	Decided.	Cons.	.38	3.25	1.10	.0015	.0640	.0246	.0394	.12	.0000	.0000	.38	1.0
33152	Oct. 1	Decided.	Cons.	.38	3.00	1.00	.0025	.0760	.0280	.0480	.11	.0010	.0000	.36	1.1
33218	Oct. 8	Decided.	Heavy.	.34	3.25	1.45	.0140	.0508	.0294	.0214	.14	.0010	.0000	.40	1.1
33306	Oct. 15	Slight.	Cons.	.43	3.30	1.30	.0224	.0352	.0244	.0108	.14	.0030	.0001	.51	1.1
33448	Oct. 25	Slight.	Cons.	.31	3.35	1.35	.0088	.0400	.0280	.0120	.14	.0050	.0003	.39	0.6
33478	Oct. 29	Slight.	Slight.	.34	3.40	1.50	.0100	.0358	.0294	.0064	.14	.0070	.0003	.44	0.8
33573	Nov. 5	Slight.	Slight.	.40	2.45	1.20	.0070	.0340	.0288	.0052	.13	.0080	.0004	.45	0.8
33661	Nov. 14	Slight.	Cons.	.38	3.20	1.60	.0032	.0344	.0254	.0090	.14	.0080	.0001	.55	0.6
33703	Nov. 19	V. slight.	Slight.	.39	3.65	1.75	.0024	.0328	.0262	.0066	.15	.0070	.0001	.49	1.0
33810	Nov. 26	Slight.	Slight.	.35	3.85	1.60	.0028	.0278	.0240	.0038	.14	.0110	.0001	.48	1.0
33898	Dec. 3	V. slight.	V. slight.	.37	3.50	1.15	.0018	.0292	.0240	.0052	.14	.0050	.0001	.53	0.8
33987	Dec. 10	V. slight.	Slight.	.37	3.10	1.05	.0020	.0282	.0234	.0048	.13	.0080	.0001	.54	1.0
34113	Dec. 17	V. slight.	V. slight.	.40	3.55	1.30	.0024	.0254	.0222	.0032	.14	.0110	.0002	.55	0.8
34209	Dec. 24	V. slight.	Slight.	.33	3.40	1.40	.0040	.0264	.0220	.0044	.17	.0110	.0002	.48	0.6

Averages by Years.

-	1888	-	-	.13	2.91	1.20	.0019	.0332	-	-	.12	.0047	.0001	-	-
-	1889	-	-	.12	2.42	1.08	.0028	.0461	.0237	.0224	.10	.0033	.0002	-	-
-	1890	-	-	.15	2.96	1.54	.0029	.0387	.0210	.0177	.10	.0065	.0001	-	0.9
-	1891	-	-	.20	3.00	1.42	.0050	.0425	.0228	.0197	.09	.0050	.0001	-	0.8
-	1894	-	-	.37	3.39	1.47	.0009	.0221	.0165	.0056	.16	.0018	.0000	.42	1.1
-	1895	-	-	.29	3.35	1.55	.0028	.0315	.0201	.0114	.18	.0030	.0000	.41	1.1
-	1896	-	-	.26	3.25	1.41	.0042	.0404	.0220	.0184	.15	.0031	.0000	.37	1.0
-	1897	-	-	.33	3.28	1.67	.0039	.0453	.0267	.0186	.15	.0028	.0000	.43	0.8
-	1898	-	-	.29	2.90	1.44	.0020	.0373	.0218	.0155	.15	.0016	.0000	.38	0.7
-	1899	-	-	.27	2.76	1.22	.0036	.0409	.0213	.0196	.13	.0037	.0001	.40	0.5
-	1900*	-	-	.42	3.16	1.29	.0032	.0312	.0221	.0091	.12	.0030	.0001	.46	0.7

Note to analyses of 1900: Odor, generally vegetable, occasionally unpleasant, generally becoming stronger on heating.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

SPRINGFIELD AND LUDLOW.

Microscopical Examination of Water from Ludlow Reservoir.

[Number of organisms per cubic centimeter.]

	1900.										
	May.	June.	July.	July.	July.	Aug.	Sept.	Sept.	Sept.	Oct.	Oct.
Day of examination,	12	12	10	19	31	15	12	21	26	2	9
Number of sample,	31229	31516	31956	32079	32293	32471	32870	33012	33068	33152	33218
PLANTS.											
Diatomaceæ,	86	21	31	238	96	108	8	40	42	33	15
Asterionella,	86	0	5	30	96	64	8	0	14	16	12
Melosira,	0	7	26	200	0	24	0	0	0	0	3
Synedra,	0	4	0	3	0	0	0	2	4	3	0
Cyanophyceæ,	0	0	0	0	6	26	398	1,290	924	574	176
Anabæna,	0	0	0	0	0	22	376	1,288	920	574	176
Cœlosphærium,	0	0	0	0	0	0	20	0	0	0	0
Algæ,	53	1	211	49	958	736	114	114	780	289	282
Cosmarium,	0	0	1	0	6	2	0	0	744	274	272
Protococcus,	34	0	203	40	916	706	86	80	12	0	0
ANIMALS.											
Rhizopoda, Arcella,	0	0	0	0	0	2	0	0	0	0	0
Infusoria,	261	12	60	40	398	592	88	2	4	13	1
Dinobryon,	254	12	0	0	312	550	0	0	0	0	0
Euglena,	0	0	60	30	2	0	2	0	0	3	0
Mallomonas,	1	0	0	9	72	6	0	0	0	0	1
Peridinium,	0	0	0	1	0	4	20	0	0	0	0
Trachelomonas,	0	0	0	0	10	30	20	2	4	2	0
Uroglena,	0	0	0	0	2	2	0	0	0	0	0
Vorticella,	0	0	0	0	0	0	46	0	0	0	0
Vermes,	1	0	0	0	0	0	0	0	0	0	2
Crustacea,	0	0	0	0	pr.	pr.	0	0	pr.	pr.	pr.
Cyclops,	0	0	0	0	pr.	pr.	0	0	pr.	pr.	pr.
Daphnia,	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	5	3	3	8	7	10	16	10	10	7	10
TOTAL,	406	37	305	335	1,465	1,474	624	1,456	1,760	916	486

SPRINGFIELD AND LUDLOW.

Microscopical Examination of Water from Ludlow Reservoir — Concluded.

[Number of organisms per cubic centimeter.]

	1900.										
	Oct.	Oct.	Oct.	Nov.	Nov.	Nov.	Nov.	Dec.	Dec.	Dec.	Dec.
Day of examination,	16	26	30	6	15	20	28	4	11	18	26
Number of sample,	33306	33448	33478	33573	33661	33703	33810	33898	33987	34113	34209
PLANTS.											
Diatomaceæ,	25	62	32	57	92	51	19	30	14	55	0
Asterionella,	0	16	6	48	65	43	15	29	9	0	0
Melosira,	6	6	4	0	0	0	2	0	0	0	0
Synedra,	0	32	2	0	1	0	2	0	5	51	0
Cyanophyceæ,	24	10	10	0	1	0	0	0	0	0	0
Anabæna,	23	10	8	0	0	0	0	0	0	0	0
Cœlosphærium,	0	0	1	0	1	0	0	0	0	0	0
Algæ,	49	322	63	1,096	49	166	260	133	101	6	6
Cosmarium,	28	216	1	0	7	0	1	1	3	0	0
Protococcus,	8	0	42	1,060	19	149	252	128	91	6	6
ANIMALS.											
Rhizopoda, Arcella,	0	0	0	0	0	0	0	0	0	0	0
Infusoria,	8	10	8	9	4	2	3	0	18	0	10
Dinobryon,	0	0	0	0	0	0	0	0	0	0	0
Euglena,	2	0	0	0	0	0	0	0	14	0	9
Mallomonas,	0	0	0	3	0	1	0	0	0	0	0
Peridinium,	0	0	0	0	0	0	2	0	1	0	0
Trachelomonas,	2	8	6	4	4	0	0	0	0	0	0
Uroglena,	0	0	0	0	0	1	0	0	0	0	0
Vorticella,	0	0	0	0	0	0	0	0	0	0	0
Vermes,	0	0	2	1	1	0	0	0	1	1	1
Crustacea,	pr.	pr.	pr.	pr.	pr.	0	pr.	0	0	0	0
Cyclops,	pr.	pr.	pr.	pr.	pr.	0	pr.	0	0	0	0
Daphnia,	pr.	0	0	0	0	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	8	10	8	10	5	5	5	5	3	3	3
TOTAL,	114	414	123	1,173	152	224	287	168	137	65	20

SPRINGFIELD AND LUDLOW.

Chemical Examination of Water from the Receiving Basin of the Springfield Water Works at Ludlow.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
29994	Jan. 18	Slight.	V. slight.	.26	3.75	1.25	.0028	.0148	.0126	.0022	.16	.0050	.0001	.41	1.3
30207	Feb. 15	Decided.	Slight.	.40	2.75	1.40	.0002	.0234	.0194	.0040	.10	.0040	.0001	.63	0.3
30445	Mar. 13	V. slight.	V. slight.	.29	2.70	0.95	.0006	.0118	.0114	.0004	.11	.0040	.0000	.39	0.3
30946	Apr. 9	V. slight.	Slight.	.22	2.60	0.85	.0000	.0104	.0102	.0002	.13	.0010	.0001	.35	0.5
31169	May 7	V. slight.	Slight.	.38	3.00	1.10	.0000	.0160	.0144	.0016	12	.0010	.0000	.55	0.6
31517	June 11	Slight.	Cons.	.40	3.05	1.20	.0006	.0192	.0160	.0032	.12	.0010	.0000	.54	0.8
31955	July 9	Slight.	Cons.	.44	3.15	1.25	.0006	.0208	.0176	.0032	.12	.0020	.0000	.42	0.8
32292	July 30	Slight.	Slight.	.62	3.85	1.60	.0008	.0302	.0246	.0056	.11	.0000	.0000	.68	0.8
32470	Aug. 14	Slight.	Cons.	.51	3.80	1.70	.0012	.0308	.0224	.0084	.13	.0000	.0000	.55	1.0
32869	Sept. 11	Decided.	Cons.	.42	3.20	1.20	.0030	.0390	.0224	.0166	.12	.0010	.0000	.43	1.0
33011	Sept. 20	Slight.	Cons.	.36	3.50	1.35	.0010	.0400	.0214	.0186	.15	.0010	.0000	.42	1.1
33067	Sept. 25	Slight.	Cons.	.35	3.35	1.20	.0015	.0395	.0202	.0193	.13	.0000	.0000	.37	1.0
33151	Oct. 1	Decided.	Cons.	.35	3.25	1.00	.0020	.0356	.0206	.0150	.14	.0040	.0001	.37	1.0
33217	Oct. 8	Decided.	Heavy.	.30	3.60	1.35	.0090	.0368	.0248	.0120	.14	.0010	.0000	.39	1.3
33305	Oct. 15	Slight.	Cons.	.72	4.05	1.80	.0036	.0268	.0232	.0036	.16	.0010	.0000	.89	1.0
33449	Oct. 25	Slight.	Cons.	.46	4.20	1.60	.0040	.0296	.0224	.0072	.18	.0030	.0000	.65	0.8
33477	Oct. 29	Slight.	Slight.	.52	4.60	1.75	.0048	.0270	.0232	.0038	.22	.0020	.0000	.71	1.1
33572	Nov. 5	Slight.	Cons.	.42	4.10	1.60	.0040	.0220	.0188	.0032	.16	.0020	.0001	.50	1.1
33660	Nov. 14	Decided.	Cons.	.70	4.30	1.80	.0016	.0232	.0196	.0036	.22	.0070	.0000	.78	1.3
33702	Nov. 19	Slight.	Cons.	.44	4.40	1.70	.0024	.0200	.0172	.0028	.20	.0040	.0001	.61	1.0
33809	Nov. 26	Slight.	Slight.	.46	3.80	1.55	.0036	.0168	.0134	.0034	.19	.0060	.0001	.61	1.3
33897	Dec. 3	V. slight.	Slight.	.47	3.50	1.10	.0012	.0142	.0136	.0006	.18	.0020	.0000	.62	1.0
33986	Dec. 10	V. slight.	V. slight.	.51	3.30	1.10	.0018	.0134	.0122	.0012	.15	.0050	.0001	.60	1.0
34112	Dec. 17	V. slight.	V. slight.	.41	3.65	1.15	.0014	.0146	.0132	.0014	.16	.0090	.0000	.51	1.0
34208	Dec. 24	V. slight.	Slight.	.31	3.65	1.40	.0024	.0156	.0132	.0024	.18	.0140	.0000	.46	1.1

Averages by Years.

-	1891	-	-	.31	3.27	1.20	.0011	.0225	.0147	.0078	.09	.0049	.0001	-	1.0
-	1892	-	-	.44	3.79	1.39	.0004	.0164	.0127	.0037	.14	.0089	.0001	-	1.3
-	1893	-	-	.49	3.76	1.39	.0009	.0204	.0146	.0058	.15	.0026	.0001	.51	1.2
-	1894	-	-	.49	3.68	1.42	.0010	.0196	.0151	.0045	.16	.0027	.0000	.46	1.6
-	1895	-	-	.47	3.86	1.61	.0019	.0212	.0162	.0050	.18	.0050	.0000	.50	1.3
-	1896	-	-	.43	3.71	1.37	.0012	.0182	.0150	.0032	.15	.0051	.0000	.50	1.1
-	1897	-	-	.51	3.49	1.40	.0013	.0185	.0154	.0031	.16	.0051	.0000	.51	1.0
-	1898	-	-	.45	3.54	1.54	.0011	.0162	.0131	.0031	.15	.0048	.0000	.45	0.9
-	1899	-	-	.38	3.43	1.36	.0014	.0177	.0155	.0022	.13	.0044	.0000	.49	0.8
-	1900*	-	-	.40	3.34	1.29	.0014	.0215	.0168	.0047	.14	.0027	.0000	.51	0.8

NOTE to analyses of 1900: Odor, generally vegetable, occasionally musty or unpleasant, generally becoming stronger on heating.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

SPRINGFIELD AND LUDLOW.

Chemical Examination of Water from Chapin Pond, Ludlow.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Sus-pended.					
	1900.														
29990	Jan. 18	V. slight.	V. slight.	.03	2.55	0.90	.0012	.0170	.0128	.0042	.12	.0010	.0001	.17	0.8
30204	Feb. 15	Decided.	Cons.	.04	2.40	1.00	.0000	.0162	.0126	.0036	.10	.0030	.0000	.16	0.6
30442	Mar. 13	Decided.	Cons.	.02	2.20	0.75	.0004	.0156	.0116	.0040	.10	.0010	.0000	.15	0.5
30943	Apr. 9	V. slight.	Slight.	.02	2.15	0.65	.0000	.0144	.0110	.0034	.09	.0010	.0000	.22	0.3
31166	May 7	V. slight.	Slight.	.09	2.25	0.70	.0000	.0146	.0124	.0022	.09	.0000	.0000	.21	0.5
31515	June 11	V. slight.	Slight.	.08	2.35	1.00	.0002	.0184	.0152	.0032	.10	.0010	.0000	.30	0.5
31953	July 9	Slight.	Slight.	.06	2.00	0.75	.0000	.0200	.0134	.0066	.08	.0020	.0000	.28	0.3
32617	Aug. 23	V slight.	Slight.	.04	2.50	0.75	.0000	.0198	.0166	.0032	.10	.0040	.0000	.30	0.5
32866	Sept. 11	Slight.	Slight.	.06	2.35	0.95	.0002	.0204	.0168	.0036	.08	.0010	.0000	.26	0.2
33214	Oct. 8	V. slight.	Slight.	.05	3.35	1.95	.0006	.0190	.0158	.0032	.10	.0020	.0000	.23	0.5
33569	Nov. 5	V. slight.	Slight.	.00	2.05	0.95	.0050	.0204	.0178	.0026	.12	.0020	.0000	.21	0.3
33894	Dec. 3	V. slight.	Slight.	.09	2.35	0.80	.0050	.0230	.0174	.0056	.10	.0030	.0000	.20	0.8
Av...	....	....	....	.05	2.37	0.93	.0010	.0182	.0144	.0038	.10	.0017	.0000	.22	0.5

Odor, generally vegetable or unpleasant, occasionally none. On heating, the odor in January, March, April and December was fishy.

Microscopical Examination.

The organism *Uroglena* was found in small numbers in the first four and last two samples.

Chemical Examination of Water from Five Mile Pond, Springfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total	Dissolved.	Sus-pended.					
	1900.														
29869	Jan. 8	V. slight.	Cons.	.08	2.95	1.20	.0326	.0364	.0186	.0178	.15	.0030	.0000	.26	0.6
29991	Jan. 18	V. slight.	V. slight	.04	2.65	0.90	.0368	.0204	.0136	.0068	.16	.0010	.0001	.17	0.2
29992	Jan. 18	V. slight.	V. slight.	.02	1.75	0.80	.0002	.0162	.0150	.0012	.12	.0010	.0001	.17	0.2
30205	Feb. 15	Slight.	V. slight.	.11	2.05	0.90	.0346	.0156	.0138	.0018	.11	.0020	.0000	.21	0.6
30443	Mar. 13	Slight.	Cons.	.11	2.85	0.85	.0440	.0190	.0158	.0032	.15	.0040	.0000	.19	0.5
30944	Apr. 9	V. slight.	Cons.	.06	2.45	0.55	.0268	.0150	.0138	.0012	.11	.0030	.0000	.19	0.3
31167	May 7	V. slight.	Cons.	.10	2.65	0.75	.0062	.0238	.0160	.0078	.14	.0010	.0001	.29	0.5
31954	July 9	V. slight.	Slight.	.16	2.85	1.15	.0000	.0284	.0258	.0026	.13	.0010	.0000	.35	0.6
32618	Aug. 23	Slight.	Slight.	.11	2.50	0.80	.0002	.0270	.0252	.0018	.13	.0040	.0000	.32	0.5
32867	Sept. 11	V. slight.	Slight.	.10	2.60	0.95	.0002	.0266	.0240	.0026	.15	.0010	.0000	.33	0.3
33215	Oct. 8	V. slight.	Slight.	.04	2.70	1.10	.0012	.0218	.0204	.0014	.14	.0020	.0000	.27	0.3
33570	Nov. 5	V. slight.	Slight.	.10	2.65	1.05	.0106	.0248	.0206	.0042	.16	.0020	.0000	.21	0.5
33895	Dec. 3	V. slight.	V. slight.	.08	2.50	0.75	.0148	.0236	.0202	.0034	.16	.0050	.0000	.22	0.6

SPRINGFIELD AND LUDLOW.

Chemical Examination of Water from Five Mile Pond, Springfield — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
-	1897	-	-	.09	2.05	1.05	.0016	.0230	.0207	.0023	.14	.0017	.0000	.31	0.4
-	1898	-	-	.14	2.24	1.20	.0015	.0252	.0222	.0030	.15	.0019	.0000	.34	0.5
-	1899	-	-	.11	2.21	1.04	.0088	.0222	.0193	.0029	.12	.0030	.0000	.27	0.3
-	1900*	-	-	.09	2.57	0.89	.0147	.0227	.0192	.0035	.14	.0024	.0000	.25	0.5

NOTE to analyses of 1900: Odor of the first sample, decidedly fishy and unpleasant; of the others, vegetable or none. On heating, the odor of all of the samples became vegetable or unpleasant, and of Nos. 29992 and 31167, fishy. —— No. 29992 was collected from the portion of the pond on the north side of the Boston & Albany Railroad; the other samples were collected from the southerly portion of the pond. This pond was not used for the supply of the city during 1900.

Microscopical Examination.

The organism *Synura* was found in considerable numbers in the first sample.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Chemical Examination of Water from Loon Pond, Springfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29993	Jan. 18	None.	V. slight.	.01	2.00	0.80	.0016	.0186	.0164	.0022	.24	.0010	.0000	.16	0.8
30206	Feb. 15	Slight.	Slight.	.05	2.50	1.15	.0002	.0172	.0150	.0022	.19	.0060	.0000	.18	1.0
30444	Mar. 13	Slight.	Slight.	.06	2.30	0.75	.0014	.0148	.0142	.0006	.18	.0020	.0002	.16	0.6
30945	Apr. 9	V. slight.	Slight.	.02	1.95	0.70	.0000	.0126	.0114	.0012	.16	.0020	.0000	.20	0.5
31168	May 7	V. slight.	Slight.	.04	2.15	0.60	.0006	.0142	.0132	.0010	.21	.0010	.0000	.16	0.6
32619	Aug. 23	V. slight	Slight.	.04	2.50	0.70	.0000	.0212	.0180	.0032	.17	.0020	.0000	.24	0.8
32868	Sept. 11	Slight.	Cons.	.03	2.65	0.85	.0000	.0230	.0188	.0042	.22	.0010	.0000	.15	0.5
33216	Oct. 8	V. slight.	Slight.	.04	2.70	1.00	.0014	.0216	.0190	.0026	.19	.0010	.0000	.19	1.6
33571	Nov. 5	None.	Slight.	.02	2.50	1.05	.0014	.0198	.0178	.0020	.21	.0020	.0001	.18	0.8
33896	Dec. 3	V. slight.	V. slight.	.04	2.50	0.75	.0020	.0176	.0166	.0010	.20	.0020	.0001	.16	1.0
Av...	....	....	....	.03	2.37	0.83	.0009	.0181	.0161	.0020	.20	.0020	.0000	.18	0.8

Odor of No. 31168, faintly unpleasant; of the others, faintly vegetable or none. —— The water of this pond was not used for the supply of the city during 1900.

SPRINGFIELD AND LUDLOW.

Chemical Examination of Water from Swift River at Enfield and Prescott.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1899.														
28622	Sept. 15	Decided.	V. slight.	.36	4.00	1.50	.0008	.0194	.0184	.0010	.08	.0010	.0000	.51	0.6
28623	Sept. 15	V. slight.	V. slight.	.04	2.85	0.90	.0002	.0044	.0042	.0002	.11	.0030	.0000	.07	0.6

Odor of the first sample, distinctly vegetable; of the last, none. —— The first sample was collected from the river, above the mill in Enfield; the last, from the west branch of the river, at the bridge above Saw-mill Pond in Prescott.

Chemical Examination of Water from the East Branch of the Westfield River at Huntington.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1899.														
28807	Sept. 29	V. slight.	V. slight.	.40	3.75	1.50	.0004	.0170	.0166	.0004	.12	.0030	.0000	.64	1.7
29563	Dec. 4	V. slight.	V. slight.	.15	3.00	1.10	.0002	.0078	.0076	.0002	.11	.0020	.0001	.28	1.0
29653	Dec. 13	Decided.	Cons.	.65	3.75	1.75	.0004	.0238	.0176	.0062	.13	.0050	.0001	.69	1.7
29777	Dec. 26	V. slight.	V. slight.	.16	3.10	1.25	.0006	.0088	.0084	.0004	.09	.0040	.0000	.31	1.1

Odor of the last sample, none; of the others, none, becoming faintly vegetable on heating. —— The samples were collected from the east branch of the Westfield River, about half a mile above its junction with the middle branch.

Chemical Examination of Water from the Middle Branch of the Westfield River at Huntington.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1899.														
28806	Sept. 29	V. slight.	V. slight.	.35	3.25	1.25	.0002	.0142	.0130	.0012	.12	.0020	.0000	.64	1.4
29564	Dec. 4	V. slight.	V. slight.	.10	2 85	0.90	.0000	.0074	.0068	.0006	.11	.0040	.0000	.22	1.3
29654	Dec. 13	Slight	Slight.	.41	3.30	1.45	.0000	.0160	.0146	.0014	.12	.0050	.0001	.51	1.3
29778	Dec. 26	V. slight.	V. slight.	.10	2.85	1.05	.0000	.0072	.0064	.0008	.09	.0020	.0000	.26	1.1

Odor of the third sample, none; of the others, none, becoming faintly vegetable on heating. —— The samples were collected from the middle branch of the Westfield River, about 3.5 miles above its junction with the east branch.

SPRINGFIELD AND LUDLOW.

The advice of the State Board of Health to the board of health of Springfield, relative to the use of Westfield River as a source of ice supply, may be found on page 101 of this volume.

The advice of the Board, relative to the quality of the water of two springs used by the public for drinking purposes, may be found on page 47 of this volume. The results of analyses of samples of water collected from these springs are given in the following table : —

Chemical Examination of Water from Dickinson's and Ingersoll Grove Springs, Springfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
32384	Aug. 6	None.	None.	.00	26.70	.0008	.0024	2.35	.7600	.0000	.04	8.9	.0020
32385	Aug. 6	None.	None.	.00	11.20	.0000	.0004	0.88	.5600	.0000	.03	3.5	.0030

Odor, none. —— The first sample was collected from Dickinson's Spring, on State Street; the last, from Ingersoll Grove Spring, near Worthington and Cornell streets.

Water Supply of Stockbridge. — Stockbridge Water Company.

Chemical Examination of Water from Lake Averic, Stockbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30307	Feb. 26	V. slight.	V. slight.	.07	7.45	1.60	.0016	.0154	.0140	.0014	.09	.0030	.0000	.25	5.0
31079	Apr. 24	Slight.	Cons.	.05	5.25	1.15	.0008	.0124	.0108	.0016	.09	.0010	.0000	.26	3.3
31859	June 26	V. slight.	V. slight.	.08	5.90	1.05	.0056	.0210	.0190	.0020	.09	.0020	.0000	.29	3.8
32715	Aug. 29	V. slight.	V. slight.	.10	5.85	1.15	.0002	.0202	.0184	.0018	.06	.0010	.0000	.34	3.4
33491	Oct. 29	None.	None.	.09	6.25	1.25	.0028	.0196	.0188	.0008	.08	.0020	.0000	.27	4.0
34239	Dec. 26	V. slight.	Slight.	.08	6.50	1.30	.0016	.0202	.0178	.0024	.10	.0040	.0001	.42	4.3
Av...	....	....	....	.08	6.20	1.25	.0021	.0181	.0165	.0016	.08	.0022	.0000	.30	4.0

Odor, generally faintly vegetable, occasionally unpleasant, becoming stronger, and in April and December, also fishy, on heating. —— The last sample was collected from a faucet at the pumping station; the others, from the lake.

Water Supply of Stoneham.

(See *Wakefield.*)

Water Supply of Stoughton.

Chemical Examination of Water from the Well of the Stoughton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30061	Jan. 30	V. slight.	None.	.24	3.75	.0008	.0102	.33	.0010	.0000	0.37	0.5	-
30357	Mar. 1	V. slight.	None.	.16	3.35	.0004	.0012	.31	.0020	.0000	0.28	0.3	-
30792	Mar. 27	V. slight.	V. slight.	.08	3.25	.0006	.0044	.31	.0020	.0003	0.13	0.8	-
31089	Apr. 25	V. slight.	V. slight.	.18	3.00	.0000	.0078	.28	.0020	.0000	0.14	0.5	-
31411	May 31	V. slight.	Slight.	.08	3.45	.0006	.0070	.37	.0070	.0000	0.16	1.0	-
31884	June 27	Slight.	Cons.	.10	3.15	.0016	.0098	.31	.0020	.0000	0.16	0.6	.0090
32350	Aug. 1	V. slight.	V. slight.	.09	3.50	.0002	.0074	.29	.0030	.0000	0.20	0.3	.0080
32610	Aug. 22	Slight.	Cons.	.13	3.60	.0000	.0090	.30	.0010	.0001	0.13	0.3	.0030
33087	Sept. 26	V. slight.	Slight.	.17	3.80	.0010	.0058	.33	.0040	.0001	0.22	0.5	.0040
33488	Oct. 29	V. slight.	V. slight.	.48	3.80	.0016	.0154	.38	.0020	.0000	0.65	0.8	.0160
33831	Nov. 27	V. slight.	V. slight.	.90	3.60	.0024	.0208	.38	.0080	.0000	1.11	1.0	.0050
34245	Dec. 27	None.	V. slight.	.09	4.00	.0004	.0052	.34	.0080	.0000	0.19	0.5	.0120
Av...	....	....	....	.22	3.52	.0008	.0087	.33	.0035	.0000	0.31	0.6	.0047

Odor of No. 31411, faintly vegetable, becoming stronger on heating; of the others, none, becoming vegetable in No. 31884 and the last three samples, on heating. —— The samples were collected from a faucet at the pumping station.

Water Supply of Swampscott.

(See *Metropolitan Water District*, pages 109–128.)

Water Supply of Taunton.

Chemical Examination of Water from Assawompsett Pond, Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30034	Jan. 23	V. slight.	V. slight.	.19	2.95	1.05	.0008	.0340	.0160	.0180	.47	.0020	.0000	.40	0.3
30787	Mar. 26	V. slight.	Slight.	.32	3.40	1.30	.0004	.0164	.0158	.0006	.49	.0010	.0002	.56	0.5
31335	May 21	V. slight.	Slight.	.32	3.20	1.35	.0016	.0164	.0158	.0006	.49	.0040	.0000	.60	0.3
32302	July 30	Slight.	V. slight.	.21	3.15	1.00	.0004	.0204	.0174	.0030	.46	.0000	.0000	.50	0.3
32534	Aug. 16	V. slight.	V. slight.	.20	3.10	1.00	.0016	.0198	.0174	.0024	.55	.0000	.0000	.45	0.3
33110	Sept 26	V. slight.	V. slight.	.10	3.00	1.00	.0010	.0188	.0168	.0020	.54	.0010	.0000	.38	0.3
33845	Nov. 28	V. slight.	V. slight.	.10	2.80	1.20	.0018	.0164	.0146	.0018	.54	.0020	.0000	.34	0.6
34183	Dec. 19	V. slight.	V. slight.	.06	3.00	1.05	.0012	.0210	.0192	.0018	.56	.0010	.0001	.34	0.3

TAUNTON.

Chemical Examination of Water from Assawompsett Pond, Lakeville — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
-	1894	-	-	.33	3.22	1.26	.0003	.0157	.0132	.0025	.51	.0021	.0000	.43	0.7
-	1895	-	-	.36	3.34	1.54	.0005	.0185	.0157	.0028	.53	.0013	.0000	.50	0.7
-	1896	-	-	.33	3.58	1.47	.0008	.0179	.0160	.0019	.54	.0032	.0000	.52	0.9
-	1897	-	-	.36	3.56	1.57	.0011	.0206	.0177	.0029	.57	.0027	.0000	.52	0.9
-	1898	-	-	.47	3.38	1.63	.0007	.0198	.0171	.0027	.53	.0012	.0000	.60	0.7
-	1899	-	-	.38	3.26	1.54	.0011	.0195	.0177	.0018	.47	.0009	.0000	.60	0.3
-	1900	-	-	.19	3.07	1.12	.0011	.0204	.0166	.0038	.51	.0014	.0000	.45	0.4

NOTE to analyses of 1900: Odor of No. 32302, distinctly disagreeable; of the others, generally vegetable or none.

Chemical Examination of Water from Elder's Pond, Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30035	Jan. 23	V. slight.	Slight.	.06	2.70	1.00	.0010	.0162	.0150	.0012	.47	.0020	.0000	.23	0.3
30788	Mar. 26	None.	V. slight.	.07	2.60	0.70	.0006	.0138	.0134	.0004	.49	.0010	.0001	.29	0.5
31336	May 21	V. slight.	Slight.	.03	2.55	0.80	.0010	.0152	.0142	.0010	.47	.0010	.0000	.25	0.3
32303	July 30	V. slight.	Slight.	.05	2.50	0.85	.0000	.0178	.0144	.0034	.46	.0000	.0000	.27	0.2
32535	Aug. 16	V. slight.	V. slight.	.02	2.50	0.75	.0004	.0180	.0162	.0018	.53	.0000	.0000	.23	0.2
33111	Sept. 26	V. slight.	V. slight.	.05	2.75	0.90	.0002	.0176	.0146	.0030	.53	.0010	.0001	.29	0.2
33846	Nov. 28	None.	V. slight.	.02	2.60	0.80	.0016	.0146	.0144	.0002	.51	.0040	.0001	.24	0.5
34184	Dec. 19	None.	V. slight.	.02	2.50	1.00	.0014	.0160	.0144	.0016	.55	.0020	.0010	.19	0.3

Averages by Years.

-	1894	-	-	.04	2.32	0.94	.0004	.0135	.0120	.0015	.42	.0015	.0000	.17	0.4
-	1895	-	-	.05	2.57	0.98	.0001	.0161	.0143	.0018	.46	.0018	.0000	.22	0.5
-	1896	-	-	.05	2.70	0.96	.0005	.0169	.0139	.0030	.50	.0017	.0000	.22	0.5
-	1897	-	-	.06	2.61	1.09	.0013	.0154	.0142	.0012	.53	.0032	.0000	.23	0.6
-	1898	-	-	.08	2.71	1.07	.0007	.0168	.0151	.0017	.55	.0012	.0000	.25	0.6
-	1899	-	-	.06	2.62	1.13	.0008	.0167	.0149	.0018	.47	.0014	.0000	.24	0.3
-	1900	-	-	.04	2.59	0.85	.0008	.0162	.0146	.0016	.50	.0014	.0002	.25	0.3

NOTE to analyses of 1900: Odor of No. 32303, faintly unpleasant; of the others, vegetable or none.

The advice of the State Board of Health to Henry P. Barstow, relative to the use of Dean Pond as a source of ice supply, may be found on page 102 of this volume. The results of an analysis of a sample of water collected from this pond are given in the following table: —

TAUNTON.

Chemical Examination of Water from Dean Pond, Taunton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
33289	1900. Oct. 12	V. slight.	Slight.	.42	5.60	2.00	.0024	.0258	.0208	.0050	.50	.0010	.0000	.68	1.3

Odor, none, becoming distinctly vegetable on heating. —— The sample was collected from Dean Pond, on Cotley River, in East Taunton.

Water Supply of Tisbury. — Vineyard Haven Water Company.

Chemical Examination of Water from the Filter-gallery at Tashmoo Spring.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
32405	1900. Aug. 7	None.	None.	.00	4.10	.0000	.0004	.97	.0050	.0000	.02	0.5	.0050

Odor, none.

Water Supply of Wakefield and Stoneham. — Wakefield Water Company.

Chemical Examination of Water from Crystal Lake, Wakefield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
30323	Feb. 27	Slight.	Slight.	.22	4.95	1.45	.0144	.0206	.0172	.0034	.52	.0180	.0001	.28	1.4
31087	Apr. 25	V. slight.	Cons.	.11	4.10	1.00	.0026	.0212	.0170	.0042	.51	.0150	.0002	.30	1.7
31875	June 27	V. slight.	Slight.	.18	4.55	1.40	.0052	.0214	.0204	.0010	.51	.0040	.0001	.33	1.7
32598	Aug. 22	Slight.	Slight.	.15	4.90	1.40	.0016	.0250	.0212	.0038	.60	.0000	.0000	.36	2.0
33430	Oct. 24	V. slight.	V. slight.	.22	4.75	1.35	.0048	.0218	.0204	.0014	.60	.0010	.0002	.27	1.8
34237	Dec. 26	V. slight.	V. slight.	.10	4.85	1.40	.0022	.0188	.0146	.0042	.64	.0180	.0001	.36	2.1

WAKEFIELD AND STONEHAM.

Chemical Examination of Water from Crystal Lake, Wakefield — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
-	1888	-	-	.13	3.69	0.92	.0009	.0167	-	-	.48	.0080	.0001	-	-
-	1893	-	-	.14	3.81	1.27	.0028	.0164	.0141	.0023	.57	.0108	.0001	.26	1.5
-	1894	-	-	.16	4.39	1.26	.0011	.0155	.0136	.0019	.67	.0105	.0001	.24	1.8
-	1895	-	-	.18	4.46	1.50	.0023	.0166	.0140	.0026	.71	.0087	.0000	.32	1.7
-	1896	-	-	.19	4.56	1.34	.0021	.0175	.0148	.0027	.71	.0130	.0000	.26	2.0
-	1897	-	-	.16	4.72	1.34	.0015	.0151	.0140	.0011	.68	.0105	.0002	.29	1.8
-	1898	-	-	.18	4.59	1.52	.0017	.0176	.0148	.0028	.64	.0132	.0002	.29	1.7
-	1899	-	-	.13	4.30	1.40	.0018	.0192	.0158	.0034	.59	.0110	.0001	.26	1.8
-	1900	-	-	.16	4.68	1.33	.0051	.0215	.0185	.0030	.56	.0093	.0001	.32	1.8

NOTE to analyses of 1900: Odor of the second sample, very faintly unpleasant; of the others, vegetable, generally becoming stronger on heating. —— The samples were collected from a faucet at the pumping station.

Water Supply of Walpole.

Chemical Examination of Water from the Wells of the Walpole Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
32365	Aug. 3	None.	None.	.00	3.70	.0000	.0002	.30	.0110	.0000	.00	0.8	.0130
33443	Oct. 24	None.	None.	.01	4.10	.0000	.0004	.32	.0040	.0000	.00	0.8	.0150

Odor, none —— The samples were collected from a faucet at the pumping station.

Water Supply of Waltham.

Chemical Examination of Water from the Well and Filter-gallery of the Waltham Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1900.												
29967	Jan. 17	None.	None.	.00	6.70	.0014	.0026	.58	.0210	.0000	.08	2.9	.0060
30257	Feb. 21	None.	None.	.00	6.90	.0006	.0028	.53	.0350	.0000	.07	3.0	.0030
30676	Mar. 21	None.	None.	.03	6.30	.0052	.0038	.55	.0160	.0000	.07	3.3	.0180
30964	Apr. 11	None.	None.	.01	6.20	.0004	.0044	.52	.0340	.0000	.07	2.7	.0030
31276	May 16	None.	None.	.00	6.30	.0002	.0036	.52	.0300	.0000	.07	2.7	.0050
31791	June 20	Slight.	V. slight.	.03	7.40	.0006	.0138	.54	.0110	.0002	.13	3.3	.0130
32305	July 31	None.	None.	.02	6.20	.0020	.0026	.53	.0150	.0000	.08	3.3	.0080
32687	Aug. 28	None.	None.	.04	6.90	.0022	.0048	.55	.0200	.0000	.11	2.9	.0070
33082	Sept. 26	V. slight.	Slight.	.08	6.70	.0036	.0086	.54	.0250	.0000	.13	2.5	.0220
33413	Oct. 24	None.	None.	.02	6.70	.0000	.0020	.54	.0420	.0000	.03	3.1	.0030
33834	Nov. 28	None.	None.	.00	6.80	.0006	.0080	.59	.0230	.0000	.07	3.3	.0060
34198	Dec. 24	None.	V. slight.	.00	7.20	.0008	.0068	.57	.0390	.0000	.04	3.1	.0090

Averages by Years.

-	1888	-	-	.00	6.70	.0009	.0054	.46	.0273	.0003	-	-	-
-	1892	-	-	.00	6.81	.0033	.0027	.45	.0162	.0000	-	3.4	.0034
-	1893	-	-	.01	6.86	.0036	.0022	.47	.0179	.0000	.06	3.4	.0020
-	1894	-	-	.02	6.75	.0028	.0019	.51	.0192	.0000	.06	3.1	.0044
-	1895	-	-	.03	7.15	.0036	.0024	.53	.0198	.0000	.05	3.4	.0082
-	1896	-	-	.03	7.36	.0034	.0018	.55	.0194	.0000	.06	3.6	.0157
-	1897	-	-	.04	7.15	.0031	.0035	.57	.0222	.0001	.06	3.6	.0108
-	1898	-	-	.07	7.31	.0034	.0028	.59	.0280	.0000	.07	3.4	.0162
-	1899	-	-	.03	7.22	.0024	.0027	.58	.0371	.0000	.05	3.1	.0082
-	1900	-	-	.02	6.69	.0015	.0053	.55	.0259	.0000	.08	3.0	.0086

Note to analyses of 1900: Odor, none. A faintly unpleasant odor was developed in two of the samples on heating.

WALTHAM.

Chemical Examination of Water from the Distributing Reservoir of the Waltham Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30965	Apr. 11	V. slight.	V. slight.	.05	6.90	.0018	.0080	.54	.0070	.0000	.10	3.3	.0130
31277	May 16	Decided.	Cons.	.04	7.80	.0008	.0134	.54	.0110	.0000	.12	3.4	.0130
31792	June 20	V. slight.	Slight.	.17	7.10	.0034	.0104	.43	.0050	.0001	.31	2.9	.0210
32306	July 31	V. slight.	Slight.	.04	7.00	.0002	.0110	.53	.0060	.0001	.10	3.3	.0050
32688	Aug. 28	V. slight.	Slight.	.06	7.10	.0022	.0198	.56	.0130	.0001	.11	3.3	.0100
33083	Sept. 26	Slight.	Slight.	.16	7.70	.0024	.0196	.55	.0110	.0000	.18	3.1	.0180
33414	Oct. 24	Decided.	Cons.	.10	7.90	.0032	.0164	.58	.0110	.0002	.13	3.1	.0100
33833	Nov. 28	V. slight.	V. slight.	.04	6.90	.0036	.0142	.57	.0140	.0000	.09	3.6	.0180
34199	Dec. 24	V. slight.	Slight.	.00	7.50	.0016	.0092	.58	.0300	.0000	.08	3.5	.0130

Averages by Years.

-	1888	-	-	.00	6.45	.0003	.0075	.46	.0248	.0003	-	-	-
-	1892	-	-	.01	6.28	.0006	.0082	.44	.0119	.0001	-	3.0	.0070
-	1893	-	-	.04	6.72	.0006	.0074	.47	.0127	.0001	.10	3.1	.0019
-	1894	-	-	.03	6.80	.0007	.0140	.51	.0078	.0001	.09	3.1	.0032
-	1895	-	-	.04	7.00	.0016	.0085	.53	.0161	.0000	.09	3.3	.0045
-	1896	-	-	.05	7.40	.0013	.0083	.55	.0172	.0001	.07	3.4	.0099
-	1897	-	-	.06	7.20	.0011	.0117	.57	.0135	.0001	.09	3.5	.0035
-	1898	-	-	.08	7.35	.0013	.0114	.59	.0140	.0001	.10	3.3	.0071
-	1899	-	-	.08	7.41	.0013	.0088	.55	.0172	.0000	.10	3.2	.0111
-	1900	-	-	.07	7.32	.0021	.0136	.54	.0120	.0001	.14	3.3	.0134

NOTE to analyses of 1900: Odor, none. Vegetable or unpleasant odors were developed in four of the samples on heating.

WATER SUPPLY OF WARE.

Chemical Examination of Water from the Large Well of the Ware Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29854	Jan. 3	None.	None.	.00	7.90	.0000	.0010	.58	.2560	.0000	.01	2.9	.0020
30402	Mar. 7	None.	None.	.00	7.40	.0000	.0002	.65	.2750	.0001	.02	2.5	.0050
31147	May 2	None.	None.	.00	8.80	.0000	.0010	.68	.3300	.0000	.02	2.7	.0050
31933	July 2	None.	None.	.00	6.90	.0000	.0004	.59	.3050	.0000	.01	2.9	.0060
32827	Sept. 5	None.	None.	.00	6.90	.0000	.0002	.58	.2350	.0000	.00	2.2	.0040
33605	Nov. 7	None.	None.	.00	7.30	.0002	.0008	.54	.2200	.0000	.02	2.2	.0030
Av....	....	....	....	.00	7.53	.0000	.0006	.60	.2702	.0000	.01	2.6	.0042

Odor, none.

WATER SUPPLY OF ONSET BAY FIRE DISTRICT, WAREHAM. — ONSET WATER COMPANY.

Chemical Examination of Water from Jonathan's Pond, Wareham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30013	Jan. 22	V. slight.	V. slight.	.13	2.15	0.85	.0000	.0070	.0070	.0000	.70	.0010	.0000	.10	0.0
31062	Apr. 21	None.	V. slight.	.00	2.40	0.80	.0004	.0098	.0094	.0004	.73	.0010	.0000	.11	0.0
32092	July 19	None.	None.	.01	2.20	0.70	.0006	.0090	.0086	.0004	.69	.0000	.0000	.10	0.0
33367	Oct. 20	None.	V. slight.	.08	2.00	0.50	.0004	.0046	.0038	.0008	.73	.0080	.0000	.14	0.2
Av...	....	....	....	.05	2.19	0.71	.0003	.0076	.0072	.0004	.71	.0025	.0000	.11	0.0

Odor, none, becoming vegetable in the first and last samples on heating. —— The first and last samples were collected from a tap at the pumping station; the others, from the pond.

WAREHAM.

The advice of the State Board of Health to Edgar Welch and others, relative to a proposed water supply for the towns of Wareham, Marion and Mattapoisett, may be found on page 48 of this volume. The results of analyses of samples of water from proposed sources of supply are given in the following table: —

Chemical Examination of Water from Blackmore's Pond in Wareham and Mary's Pond in Rochester.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
34247	Dec. 27	None.	V. slight.	.00	2.55	0.70	.0002	.0164	.0156	.0008	0.70	.0070	.0000	.10	0.0
34248	Dec. 27	None.	V. slight.	.00	2.40	0.70	.0016	.0136	.0096	.0040	0.58	.0060	.0000	.09	0.0

Odor of No. 34247, distinctly vegetable; of No. 34248, none, becoming faintly vegetable on heating. —— The first sample was collected from Blackmore's Pond, in Wareham; the last, from Mary's Pond, in Rochester.

WATERTOWN.

WATER SUPPLY OF WATERTOWN.

(See *Metropolitan Water District*, pages 109–128.)

WATER SUPPLY OF WAYLAND.

Chemical Examination of Water from the Filter-gallery of the Wayland Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1900.												
30144	Feb. 8	Slight.	V. slight.	0.72	6.85	.0034	.0290	.36	.0410	.0000	1.12	2.3	.0220
30924	Apr. 4	V. slight.	V. slight.	0.39	3.60	.0006	.0122	.30	.0130	.0001	0.48	1.0	.0090
31479	June 6	V. slight.	Slight.	1.10	5.10	.0040	.0250	.26	.0130	.0000	1.08	1.3	-
32423	Aug. 8	V. slight.	V. slight.	0.55	4.60	.0066	.0250	.29	.0110	.0000	0.72	1.3	.0630
33203	Oct. 5	V. slight.	V. slight.	0.30	3.80	.0054	.0228	.32	.0060	.0000	0.45	1.7	.0200
34020	Dec. 11	V. slight.	V. slight.	1.00	5.85	.0052	.0260	.33	.0370	.0001	1.23	1.8	.0380
Av...	....	....	....	0.68	4.97	.0042	.0233	.31	.0202	.0000	0.85	1.6	.0304

Odor, faintly vegetable or none. A vegetable odor was developed in all of the samples on heating. —— The samples were collected from a faucet at the gate-house.

Chemical Examination of Water from the Storage Reservoir of the Wayland Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30143	Feb. 8	Decided.	V. slight.	0.53	4.30	2.25	.0020	.0412	.0368	.0044	.37	.0090	.0000	0.90	0.8
30923	Apr. 4	V. slight.	V. slight.	0.42	3.10	1.50	.0000	.0164	.0144	.0020	.23	.0020	.0001	0.59	0.8
31478	June 6	V. slight.	Slight.	1.20	4.05	2.25	.0030	.0294	.0272	.0022	.24	.0070	.0000	1.24	1.0
32422	Aug. 8	V. slight.	V. slight.	0.60	3.80	1.90	.0028	.0296	.0276	.0020	.27	.0000	.0001	0.76	1.1
33201	Oct. 5	V. slight.	Slight.	0.30	4.10	1.50	.0020	.0330	.0272	.0058	.31	.0010	.0000	0.52	1.6
34019	Dec. 11	V. slight.	V slight.	1.10	6.00	3.15	.0032	.0352	.0302	.0050	.34	.0090	.0001	1.52	1.8
Av...	....	....	....	0.69	4.22	2.09	.0022	.0308	.0272	.0036	.29	.0047	.0000	0.92	1.2

Odor of the first three samples, vegetable; of the fourth and fifth, none, becoming faintly vegetable on heating; of the last, distinctly unpleasant.

Water Supply of Webster.

Chemical Examination of Water from the Well of the Webster Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1900.												
29898	Jan. 9	None.	None.	.00	3.60	.0000	.0002	.22	.0060	.0000	.02	1.3	.0020
30360	Feb. 23	None.	None.	.00	3.60	.0000	.0010	.23	.0140	.0000	.03	0.8	.0010
31173	May 7	None.	None.	.00	4.00	.0006	.0006	.22	.0100	.0000	.02	0.8	.0010
32022	July 13	None.	None.	.00	4.50	.0010	.0020	.23	.0100	.0000	.01	1.1	.0020
32958	Sept. 18	None.	None.	.00	4.30	.0006	.0012	.20	.0040	.0000	.00	1.1	.0030
33317	Oct. 16	None.	None.	.00	3.30	.0000	.0012	.21	.0040	.0000	.00	1.0	.0120
33699	Nov. 16	None.	None.	.01	3.60	.0004	.0014	.23	.0050	.0000	.01	1.3	.0040
34168	Dec. 19	None.	None.	.00	3.60	.0000	.0020	.22	.0100	.0000	.01	1.1	.0040
Av...	....	....	....	.00	3.81	.0003	.0012	.22	.0079	.0000	.01	1.1	.0036

Odor, none.

Water Supply of Wellesley.

Chemical Examination of Water from the Filter-gallery of the Wellesley Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1900.												
33062	Sept. 25	None.	V. slight.	.00	7.70	.0004	.0018	.55	.1380	.0000	.02	2.7	.0040

Odor, none.

WELLESLEY.

Chemical Examination of Water from the Well of the Wellesley Water Works at Williams Spring.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30072	Jan. 31	None.	None.	.00	10.50	.0002	.0010	.94	.5400	.0000	.03	3.8	.0010
30831	Mar. 28	None.	None.	.00	9.80	.0000	.0010	.87	.4500	.0001	.02	3.9	.0070
31413	May 31	V. slight.	V. slight.	.04	10.80	.0070	.0022	.76	.3300	.0110	.03	4.7	.0140
32285	July 30	None.	None.	.00	8.90	.0004	.0014	.78	.3300	.0000	.01	3.3	.0020
33064	Sept. 25	None.	None.	.02	11.20	.0006	.0010	.80	.4600	.0000	.01	3.3	.0080
33849	Nov. 28	None.	None.	.01	6.20	.0006	.0018	.64	.1650	.0000	.01	2.7	.0040
Av...	....	....	....	.01	9.57	.0015	.0014	.80	.3792	.0018	.02	3.6	.0060

Odor, none.

Chemical Examination of Water from the Tubular Wells of the Wellesley Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30073	Jan. 31	None.	None.	.00	7.00	.0000	.0008	.64	.0520	.0000	.03	3.0	.0010
30832	Mar. 28	None.	None.	.00	6.30	.0006	.0016	.61	.1140	.0001	.02	3.0	.0040
31412	May 31	None.	V. slight.	.02	6.20	.0016	.0040	.63	.0510	.0000	.08	2.3	.0070
32286	July 30	None.	None.	.00	7.00	.0000	.0010	.56	.0390	.0000	.01	2.7	.0020
33063	Sept. 25	V. slight.	V. slight.	.08	8.10	.0192	.0010	.61	.0740	.0320	.03	3.6	.0230
33850	Nov. 28	None.	None.	.00	6.40	.0006	.0012	.61	.0440	.0000	.01	3.1	.0040
Av...	....	....	.. ..	.02	6.83	.0037	.0016	.61	.0623	.0053	.03	2.9	.0068

Odor, none.—— The samples were collected from a faucet at the pumping station.

Wenham.

The advice of the State Board of Health to Geo. W. Fitz, relative to a supply of water for Wenham and Hamilton, to be taken from tubular wells in Hamilton, may be found on page 50 of this volume. The results of analyses of samples of water from the various test wells are given under "Hamilton."

Water Supply of Westborough.

Chemical Examination of Water from a Faucet supplied from the Westborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30306	Feb. 26	V. slight.	V. slight.	.04	2.60	0.80	.0000	.0050	.0050	.0000	.19	.0010	.0000	.07	1.0
31338	May 22	V. slight.	V. slight.	.03	2.85	0.90	.0002	.0088	.0086	.0002	.19	.0040	.0000	.13	1.0
32587	Aug. 22	V. slight.	V. slight.	.03	3.10	0.95	.0014	.0110	.0100	.0010	.19	.0020	.0000	.15	1.3
33778	Nov. 22	Decided.	Cons.	.12	5.40	3.80	.0008	.0400	.0198	.0202	.23	.0020	.0000	.58	0.3
Av...	....	....	....	.05	3.49	1.61	.0006	.0162	.0108	.0054	.20	.0022	.0000	.23	0.9

Odor of the first and third samples, none; of the second, faintly vegetable, becoming stronger on heating; of the last, faintly unpleasant, becoming stronger on heating.

Water Supply of Westfield.

Chemical Examination of Water from the Storage Reservoir of the Westfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30309	Feb. 26	Decided.	Slight.	.38	2.25	1.20	.0006	.0182	.0164	.0018	.09	.0010	.0000	.55	0.0
31365	May 22	Slight.	Slight.	.50	2.50	1.20	.0012	.0198	.0158	.0040	.09	.0050	.0000	.70	0.2
32697	Aug. 28	Slight.	Cons.	.31	2.75	1.35	.0034	.0306	.0242	.0064	.14	.0040	.0001	.61	0.0
33840	Nov. 27	Decided.	Cons.	.62	3.65	1.90	.0040	.0356	.0224	.0132	.15	.0070	.0000	.90	0.6
Av...	....	....	....	.45	2.79	1.41	.0023	.0260	.0197	.0063	.12	.0042	.0000	.69	0.2

Odor of the first two samples, faintly vegetable, becoming stronger on heating; of the third, none, becoming faintly vegetable on heating; of the last, none, becoming distinctly unpleasant on heating.

WESTFIELD.

Chemical Examination of Water from Tillottson Brook in Granville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30308	Feb. 26	V. slight.	V. slight.	.11	2.45	0.90	.0000	.0084	.0082	.0002	.10	.0030	.0000	.24	0.2
31364	May 23	None.	V. slight.	.10	2.35	0.60	.0000	.0048	.0042	.0006	.09	.0040	.0001	.22	0.2
32696	Aug. 28	V. slight.	Slight.	.09	2.90	0.75	.0040	.0060	.0052	.0008	.14	.0010	.0001	.13	0.6
33839	Nov. 27	V. slight.	V. slight.	.23	3.00	0.90	.0012	.0092	.0088	.0004	.16	.0030	.0000	.43	0.8
Av...	....	....	....	.13	2.67	0.79	.0013	.0071	.0066	.0005	.12	.0027	.0000	.25	0.4

Odor, none. On heating, the odor of the first and last samples became vegetable, and of the third, faintly unpleasant.

Water Supply of Weston. — Weston Aqueduct Company.

Chemical Examination of Water from the Well of the Weston Aqueduct Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30172	Feb. 13	None.	None.	.00	7.10	.0002	.0032	.58	.0430	.0000	.09	2.9	.0210
30966	Apr. 10	None.	None.	.03	5.80	.0002	.0026	.39	.0360	.0000	.09	2.5	.0030
31562	June 12	V. slight.	None.	.04	6.00	.0000	.0034	.42	.0500	.0000	.11	2.2	.0040
32632	Aug. 24	None.	None.	.00	6.40	.0000	.0034	.38	.0290	.0001	.05	2.3	.0040
33476	Oct. 27	None.	None.	.02	7.70	.0000	.0034	.46	.0310	.0000	.06	3.1	.0020
34008	Dec. 11	None.	None.	.01	6.70	.0008	.0074	.59	.0640	.0000	.01	3.3	.0040
Av...	....	....	....	.02	6.62	.0002	.0039	.47	.0422	.0000	.07	2.7	.0063

Odor, none.

WEST SPRINGFIELD.

Water Supply of West Springfield.

Chemical Examination of Water from the Storage Reservoir on Darby Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30960	Apr. 10	Slight.	Slight.	.14	4.55	1.15	.0004	.0160	.0088	.0072	.13	.0010	.0001	.19	2.3
32153	July 25	Slight.	Slight.	.18	5.80	1.60	.0030	.0300	.0216	.0084	.16	.0010	.0000	.33	2.7
33892	Dec. 3	Decided.	V. sllght.	.40	5.35	1.35	.0014	.0192	.0168	.0024	.19	.0120	.0001	.52	2.5
Av...	....	....	....	.24	5.23	1.37	.0016	.0217	.0157	.0060	.16	.0047	.0001	.35	2.5

Odor of the first sample, distinctly unpleasant, becoming also fishy on heating; of the second, distinctly fishy; of the third, none, becoming faintly unpleasant on heating.

Chemical Examination of Water from the Receiving Well of the West Springfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29998	Jan. 19	None.	None.	.00	7.50	.0000	.0006	.59	.2840	.0000	.02	2.6	.0040
30208	Feb. 15	V. slight.	V. slight.	.00	7.00	.0014	.0064	.57	.2600	.0000	.06	2.3	.0240
30961	Apr. 10	None.	None.	.00	5.20	.0000	.0014	.40	.1300	.0000	.03	2.2	.0010
32154	July 25	None.	None.	.00	6.90	.0000	.0010	.52	.2500	.0000	.02	2.5	.0000
33893	Dec. 3	V. slight.	None.	.01	7.70	.0000	.0016	.70	.3300	.0000	.03	2.9	.0070
Av...	....	....	....	.00	6.86	.0003	.0022	.56	.2508	.0000	.03	2.5	.0072

Odor, none, becoming faintly vegetable in the second sample on heating.

Water Supply of the Southworth Company, Mittineague.

The advice of the State Board of Health to the Southworth Company, relative to the quality of the water of certain springs used by the company for the supply of its tenement-houses, and relative to the quality of certain proposed additional sources of supply, may

WEST SPRINGFIELD.

be found on page 52 of this volume. The results of analyses of samples of water collected during the investigation are given in the following table: —

Chemical Examination of Water from the Present and Proposed Sources of Supply of the Southworth Company, Mittineague.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
33484	Oct. 29	V. slight.	V. slight.	.05	13.50	.0010	.0078	.72	.0330	.0000	.02	7.4	.0130
33485	Oct. 29	None.	V. slight.	.01	12.90	.0004	.0062	.73	.0410	.0000	.02	7.3	.0100
33418	Oct. 23	None.	V. slight.	.00	16.60	.0000	.0012	.68	.3500	.0000	.01	8.4	.0100
33419	Oct. 23	None.	Slight.	.04	12.50	.0120	.0068	.56	.0830	.0005	.04	5.6	.0050

Odor of No. 33418, faintly earthy; of the others, none. —— The first two samples were collected from the springs from which the present supply is obtained; the last two, from two springs located a short distance north of the Boston & Albany Railroad, from which it was proposed to obtain an additional supply.

Water Supply of Weymouth.

Chemical Examination of Water from Great Pond, in Weymouth.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30044	Jan. 29	V. slight.	Slight.	.67	4.15	1.90	.0006	.0216	.0208	.0008	.52	.0020	.0000	.86	0.3
31081	Apr. 25	V. slight.	Slight.	.71	3.90	1.55	.0002	.0162	.0152	.0010	.51	.0010	.0000	.74	0.3
32372	Aug. 6	V. slight.	Slight.	.54	3.60	1.40	.0006	.0190	.0164	.0026	.48	.0020	.0000	.71	0.2
33530	Oct. 30	Slight.	Cons.	.39	3.75	1.35	.0020	.0204	.0168	.0036	.54	.0050	.0000	.45	0.2
Av...	....	....	....	.58	3.85	1.55	.0008	.0193	.0173	.0020	.51	.0025	.0000	.69	0.2

Odor of the first sample, none, becoming faintly vegetable on heating; of the second, faintly vegetable, becoming stronger on heating; of the third, none; of the last, faintly unpleasant, becoming stronger on heating. —— The samples were collected from a faucet in the town.

Water Supply of Whitman.

Chemical Examination of Water from the Filter-gallery of the Whitman Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30390	Mar. 7	Slight.	Slight.	0.41	4.35	.0010	.0152	0.61	.0140	.0001	0.55	0.8	.0250
31476	June 6	Slight.	Slight.	1.00	6.10	.0050	.0342	0.66	.0120	.0001	1.02	1.1	.0480
32829	Sept. 5	Slight.	Cons.	0.40	7.80	.0028	.0360	1.52	.0050	.0000	0.65	2.1	.0300
33948	Dec. 5	Decided.	Slight.	0.85	8.00	.0102	.0202	1.04	.0390	.0001	0.66	2.5	.1500
Av...	....	....	....	0.66	6.56	.0047	.0264	0.96	.0175	.0001	0.72	1.6	.0632

Odor of the first and last samples, none; of the second, faintly vegetable, becoming stronger on heating; of the third, faintly unpleasant.

Chemical Examination of Water from Hobart's Pond, Whitman.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30389	Mar. 7	Slight.	Slight.	0.40	4.05	1.45	.0012	.0160	.0152	.0008	0.58	.0100	.0001	0.57	0.8
31475	June 6	Slight.	Slight.	1.10	5.35	2.50	.0034	.0402	.0378	.0024	0.60	.0080	.0000	1.09	1.3
32828	Sept. 5	Slight.	Cons.	0.38	8.15	2.25	.0020	.0395	.0292	.0103	1.50	.0020	.0000	0.67	2.1
33947	Dec. 5	Decided.	Cons.	0.78	6.70	2.50	.0096	.0324	.0262	.0062	0.94	.0210	.0004	1.00	2.1
Av...	....	....	....	0.66	6.06	2.17	.0040	.0320	.0271	.0049	0.90	.0102	.0001	0.83	1.6

Odor of the first two samples, distinctly vegetable; of the last two, distinctly unpleasant.

WILLIAMSTOWN.

Water Supply of Williamstown. — Williamstown Water Company.

Chemical Examination of Water from the Sources of Supply of the Williamstown Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
32833	Sept 5	None.	V. slight.	.00	4.15	0.60	.0002	.0016	.0016	.0000	.06	.0270	.0000	.02	2.5
32834	Sept. 5	Decided.	Heavy.	.20	6.25	0.90	.0080	.0360	.0265	.0095	.06	.0020	.0000	.22	3.5
32832	Sept. 5	None.	V. slight.	.00	11.20	-	.0000	.0004	-	-	.05	.0180	.0000	.00	6.7
32835	Sept. 5	Slight.	V. slight.	.04	14.20	-	.0008	.0036	-	-	.05	.0340	.0002	.24	9.9

Odor of the second sample, faintly unpleasant, becoming stronger on heating; of the others, none. —— The first sample was collected from Paul Brook Reservoir; the second, from Flora Glen Reservoir; the third, from Sherman Spring; the last, from a faucet supplied from Cold Spring.

Water Supply of Winchendon.

Chemical Examination of Water from the Well of the Winchendon Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
30039	Jan. 24	None.	None.	.00	2.60	.0000	.0006	.11	.0060	.0000	.02	0.5	.0210
30720	Mar. 26	None.	None.	.00	2.80	.0006	.0010	.11	.0020	.0000	.05	1.3	.0170
31394	May 28	V. slight.	None.	.00	2.50	.0000	.0006	.12	.0070	.0000	.03	0.5	.0180
32347	Aug. 1	None.	None.	.00	2.60	.0000	.0004	.09	.0010	.0000	.01	0.6	.0030
33092	Sept. 26	V. slight.	None.	.00	3.60	.0002	.0012	.10	.0040	.0000	.04	1.4	.0040
33844	Nov. 28	None.	None.	.02	3.00	.0026	.0014	.14	.0070	.0000	.01	1.6	.0040
Av...	....	....	....	.00	2.85	.0006	.0009	.11	.0045	.0000	.03	1.0	.0112

Odor, none.

WINCHENDON.

The advice of the State Board of Health to White Bros. of Winchendon Springs, relative to the quality of the water of a spring used by the public for drinking purposes, may be found on page 52 of this volume. The results of an analysis of a sample of water collected from the spring are given in the following table: —

Chemical Examination of Water from a Spring at Winchendon Springs.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
31291	1900. May 17	None.	None.	.01	8.40	.0062	.0006	.55	.0020	.0000	.09	4.2	.2600

Odor, none.

Water Supply of Winchester.

Chemical Examination of Water from the North Reservoir of the Winchester Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
30109	Feb. 5	V. slight.	V. slight.	.05	5.20	1.65	.0010	.0222	.0198	.0024	.55	.0060	.0001	.24	2.6
30917	Apr. 4	V. slight.	Slight.	.10	4.65	1.25	.0014	.0226	.0176	.0050	.49	.0030	.0002	.22	2.0
31446	June 5	V. slight.	Slight.	.08	4.65	1.45	.0020	.0190	.0176	.0014	.56	.0010	.0000	.28	2.1
32408	Aug. 8	V. slight.	Slight.	.05	5.10	1.10	.0004	.0238	.0198	.0040	.56	.0010	.0000	.29	2.3
33172	Oct. 3	Slight.	Slight.	.09	5.60	1.55	.0028	.0252	.0200	.0052	.56	.0000	.0000	.33	2.3
33944	Dec. 5	V. slight.	Slight.	.10	5.35	1.65	.0056	.0262	.0210	.0052	.49	.0080	.0002	.35	2.7
Av...	....	....	....	.08	5.09	1.44	.0022	.0232	.0193	.0039	.53	.0032	.0001	.28	2.3

Odor, vegetable or unpleasant, generally becoming stronger on heating.

WINCHESTER.

Chemical Examination of Water from the South Reservoir of the Winchester Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30110	Feb. 5	V. slight.	Slight.	.10	3.25	1.55	.0068	.0302	.0256	.0046	.32	.0040	.0002	.34	1.1
30919	Apr. 4	V. slight.	Slight.	.09	3.00	1.25	.0018	.0244	.0206	.0038	.27	.0020	.0002	.35	1.3
31447	June 5	V. slight.	Slight.	.05	3.05	1.40	.0012	.0268	.0186	.0082	.33	.0010	.0000	.32	1.4
32409	Aug. 8	V. slight.	Slight.	.08	3.10	1.00	.0002	.0242	.0200	.0042	.30	.0010	.0000	.36	1.1
33173	Oct. 3	V. slight.	Slight.	.10	3.40	1.35	.0012	.0210	.0180	.0030	.32	.0010	.0000	.44	1.6
33945	Dec. 5	V. slight.	Slight.	.12	2.90	1.10	.0182	.0242	.0214	.0028	.28	.0050	.0002	.35	1.3

Averages by Years.

-	1892	-	-	.51	5.17	2.04	.0055	.0392	.0318	.0074	.38	.0118	.0002	-	2.2
-	1893	-	-	.34	4.78	1.86	.0064	.0291	.0216	.0075	.36	.0093	.0002	.49	2.1
-	1894	-	-	.18	4.56	1.76	.0049	.0267	.0232	.0035	.41	.0024	.0001	.45	1.9
-	1895	-	-	.18	4.44	1.77	.0039	.0261	.0226	.0035	.41	.0070	.0001	.41	1.9
-	1896	-	-	.18	4.22	1.75	.0040	.0326	.0256	.0070	.37	.0036	.0000	.43	1.6
-	1897	-	-	.15	3.82	1.56	.0061	.0282	.0230	.0052	.39	.0085	.0001	.35	1.4
-	1898	-	-	.17	3.87	1.64	.0047	.0254	.0221	.0033	.40	.0026	.0000	.31	1.6
-	1899	-	-	.11	3.41	1.43	.0050	.0257	.0216	.0041	.29	.0017	.0000	.30	1.2
-	1900	-	-	.09	3.12	1.27	.0049	.0251	.0207	.0044	.30	.0023	.0001	.36	1.3

NOTE to analyses of 1900: Odor, faintly vegetable or none. A faintly vegetable or unpleasant odor was developed in all of the samples on heating.

Chemical Examination of Water from the Middle Reservoir of the Winchester Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
30111	Feb. 5	Decided.	Slight.	.33	3.55	1.90	.0016	.0388	.0312	.0076	.26	.0010	.0001	.49	1.0
30918	Apr. 4	V. slight.	Slight.	.17	2.80	1.30	.0044	.0302	.0244	.0058	.26	.0090	.0001	.35	0.8
31448	June 5	Decided.	Cons.	.34	3.65	1.75	.0024	.0452	.0340	.0112	.33	.0010	.0001	.59	1.3
32410	Aug. 8	Decided.	Cons.	.29	4.25	1.95	.0006	.0444	.0336	.0108	.35	.0000	.0000	.59	1.1
33174	Oct. 3	Decided.	Cons.	.27	4.15	2.00	.0034	.0468	.0344	.0124	.32	.0020	.0002	.58	1.4
33946	Dec. 5	Slight.	Slight.	.25	3.30	1.40	.0018	.0342	.0304	.0038	.30	.0070	.0002	.33	1.3

WINCHESTER.

Chemical Examination of Water from the Middle Reservoir of the Winchester Water Works — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
-	1895	-	-	.41	4.84	2.58	.0054	.0693	.0462	.0231	.41	.0065	.0001	.70	1.3
-	1896	-	-	.41	4.45	2.28	.0004	.0524	.0373	.0151	.36	.0053	.0000	.69	1.3
-	1897	-	-	.41	4.22	2.15	.0028	.0541	.0359	.0182	.38	.0067	.0000	.58	1.2
-	1898	-	-	.26	3.84	2.00	.0031	.0521	.0319	.0202	.33	.0030	.0001	.48	1.2
-	1899	-	-	.22	3.68	1.89	.0026	.0504	.0326	.0178	.28	.0022	.0000	.49	1.2
-	1900	-	-	.27	3.62	1.72	.0024	.0399	.0313	.0086	.30	.0033	.0001	.49	1.1

NOTE to analyses of 1900: Odor, generally vegetable or unpleasant, sometimes fishy or musty.

The advice of the State Board of Health to Chas. E. Hemingway of Winchester, relative to the use of Wedge Pond as a source of ice supply, may be found on page 102 of this volume. The results of an analysis of a sample of water collected from the pond are given in the following table: —

Chemical Examination of Water from Wedge Pond, Winchester.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
30062	**1900.** Jan. 30	Decided.	Cons.	.26	7.85	1.90	.0068	.0352	.0244	.0108	.87	.0320	.0005	.50	2.9

Odor, none, becoming distinctly fishy on heating. —— The sample was collected from the pond, at its outlet.

Water Supply of Winthrop.

(See *Metropolitan Water District*, pages 109–128.)

WOBURN.

Water Supply of Woburn.

Chemical Examination of Water from the Filter-gallery of the Woburn Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
29976	Jan. 17	None.	None.	.00	9.60	.0052	.0028	1.25	.0110	.0000	.07	4.6	.0030
30265	Feb 21	None.	V. slight.	.00	9.50	.0052	.0024	1.20	.0170	.0000	.05	4.3	.0020
30681	Mar. 21	None.	None.	.00	8.60	.0044	.0022	1.14	.0200	.0000	.05	4.3	.0010
31037	Apr. 18	None.	None.	.00	9.40	.0052	.0024	1.16	.0240	.0000	.04	4.4	.0020
31281	May 16	None.	None.	.00	8.90	.0052	.0014	1.14	.0210	.0000	.07	4.6	.0070
31814	June 21	None.	None.	.00	9.30	.0060	.0034	1.18	.0250	.0000	.08	4.9	.0010
32344	Aug. 1	None.	None.	.00	9.70	.0050	.0020	1.18	.0120	.0000	.03	4.7	.0020
32591	Aug. 22	None.	None.	.01	9.70	.0056	.0032	1.20	.0160	.0000	.07	5.0	.0010
33061	Sept. 25	None.	None.	.00	9.40	.0050	.0032	1.25	.0110	.0000	.05	4.7	.0030
33421	Oct. 24	None.	None.	.02	9.30	.0062	.0036	1.20	.0150	.0000	.04	4.4	.0060
33848	Nov. 28	None.	None.	.01	8.70	.0058	.0032	1.21	.0090	.0000	.06	5.0	.0030
34158	Dec. 19	None.	None.	.00	9.80	.0068	.0052	1.27	.0220	.0000	.03	4.6	.0070

Averages by Years.

-	1888	-	-	.00	12.00	.0012	.0032	2.50	.0346	.0000	-	-	-
-	1889	-	-	.00	10.84	.0010	.0022	2.07	.0372	.0000	-	-	-
-	1890	-	-	.01	11.06	.0012	.0023	1.91	.0481	.0000	-	5.0	-
-	1891	-	-	.00	10.85	.0008	.0015	1.79	.0668	.0000	-	4.9	-
-	1892	-	-	.00	11.27	.0012	.0024	1.95	.0542	.0000	-	5.1	-
-	1893	-	-	.00	11.50	.0022	.0018	2.04	.0447	.0000	.05	5.3	.0004
-	1894	-	-	.01	11.02	.0026	.0018	1.94	.0262	.0000	.05	5.0	.0021
-	1895	-	-	.01	10.82	.0031	.0022	1.74	.0204	.0000	.06	4.9	.0023
-	1896	-	-	.01	10.49	.0033	.0031	1.56	.0242	.0000	.04	5.0	.0011
-	1897	-	-	.01	10.06	.0041	.0032	1.36	.0202	.0000	.04	5.0	.0012
-	1898	-	-	.02	10.15	.0041	.0026	1.27	.0252	.0000	.06	4.5	.0015
-	1899	-	-	.01	9.51	.0044	.0025	1.19	.0258	.0000	.05	4.4	.0015
-	1900	-	-	.00	9.32	.0055	.0029	1.20	.0169	.0000	.05	4.6	.0032

Note to analyses of 1900: Odor of No. 31281, faintly earthy; of the others, none.

WOBURN.

Chemical Examination of Water from Horn Pond, Woburn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29975	Jan. 17	V. slight.	V. slight.	.10	8.35	2.50	.0008	.0244	.0204	.0040	1.20	.0130	.0006	.34	3.3
30264	Feb. 21	Decided.	Slight.	.33	7.15	2.15	.0192	.0260	.0226	.0034	0.77	.0100	.0010	.50	2.3
30680	Mar. 21	Decided.	Cons.	.40	6.10	2.10	.0126	.0282	.0176	.0106	0.60	.0370	.0008	.47	2.0
31036	Apr. 18	Slight.	Cons.	.28	5.90	1.90	.0026	.0266	.0182	.0084	0.66	.0570	.0004	.40	2.2
31280	May 16	Slight.	Cons.	.29	6.00	1.50	.0026	.0340	.0186	.0154	0.73	.0430	.0008	.48	2.6
31813	June 21	Slight.	Cons.	.28	6.70	1.60	.0032	.0326	.0226	.0100	0.76	.0110	.0007	.47	2.9
32343	Aug. 1	V. slight.	Slight.	.14	7.00	1.95	.0008	.0294	.0258	.0036	0.87	.0110	.0000	.42	2.9
32590	Aug. 22	Slight.	Cons.	.19	7.50	2.20	.0000	.0412	.0250	.0162	0.92	.0030	.0000	.51	2.7
33060	Sept. 25	Slight.	Cons.	.22	7.45	1.65	.0010	.0475	.0232	.0243	0.90	.0010	.0000	.48	2.6
33420	Oct. 24	Decided.	Cons.	.14	8.70	2.10	.0092	.0396	.0214	.0182	0.93	.0020	.0003	.49	3.0
33847	Nov. 28	V. slight.	V. slight.	.12	7.10	1.85	.0144	.0278	.0208	.0070	0.94	.0120	.0009	.41	3.1
34157	Dec. 19	None.	Slight.	.20	8.15	1.80	.0118	.0270	.0232	.0038	0.95	.0480	.0007	.50	3.3

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1888	-	-	.32	11.28	1.71	.0186	.0383	-	-	2.98	.0398	.0015	-	-
-	1889	-	-	.30	8.37	2.03	.0092	.0376	.0216	.0160	1.98	.0498	.0015	-	-
-	1890	-	-	.27	10.76	2.07	.0080	.0380	.0211	.0169	1.93	.0542	.0008	-	3.4
-	1891	-	-	.22	8.90	2.06	.0129	.0453	.0237	.0216	1.76	.0502	.0009	-	2.9
-	1892	-	-	.25	10.57	2.13	.0110	.0358	.0216	.0142	2.42	.0821	.0008	-	3.3
-	1893	-	-	.30	9.83	2.51	.0061	.0455	.0247	.0208	2.10	.0472	.0009	.45	3.2
-	1894	-	-	.33	9.03	1.98	.0065	.0292	.0184	.0108	1.84	.0404	.0009	.40	3.3
-	1895	-	-	.36	9.43	2.84	.0087	.0297	.0205	.0092	1.53	.0523	.0014	.48	3.4
-	1896	-	-	.27	8.27	2.43	.0043	.0321	.0199	.0122	1.18	.0476	.0010	.39	3.1
-	1897	-	-	.41	7.95	2.30	.0052	.0355	.0224	.0131	1.02	.0389	.0008	.48*	3.2
-	1898	-	-	.40	7.80	2.32	.0037	.0286	.0206	.0080	0.96	.0616	.0015	.48	3.0
-	1899	-	-	.18	7.55	2.14	.0046	.0344	.0203	.0141	0.87	.0527	.0011	.37	2.9
-	1900	-	-	.22	7.17	1.94	.0065	.0320	.0216	.0104	0.85	.0207	.0005	.46	2.7

NOTE to analyses of 1900: Odor, vegetable or unpleasant, sometimes becoming stronger on heating.

WOBURN.

Microscopical Examination of Water from Horn Pond, Woburn.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	Aug.	Aug.	Sept.	Oct.	Dec.	Dec.
Day of examination,	18	23	22	18	17	21	2	22	25	25	1	20
Number of sample,	29975	30264	30680	31036	31280	31813	32343	32590	33060	33420	33847	34157
PLANTS.												
Diatomaceæ,	29	152	220	2,308	9,342	220	0	0	8	250	900	825
Asterionella,	8	96	149	1,524	5,760	3	0	0	0	0	202	381
Cyclotella,	0	0	0	510	0	0	0	0	0	0	2	3
Fragilaria,	0	3	0	0	216	216	0	0	0	0	8	0
Melosira,	8	43	56	198	86	0	0	0	8	248	662	397
Synedra,	5	3	14	40	3,280	1	0	0	0	2	16	44
Cyanophyceæ,	0	1	0	0	0	0	37	260	428	62	1	0
Anabæna,	0	0	0	0	0	0	23	240	428	62	0	0
Cœlosphærium,	0	1	0	0	0	0	13	20	0	0	1	0
Algæ,	105	2	2	0	10	38	279	3,348	1,832	376	16	14
Protococcus,	103	2	2	0	0	20	10	0	0	0	5	9
Staurastrum,	0	0	0	0	0	0	268	3,344	1,832	374	4	2
ANIMALS.												
Infusoria,	2	22	12	6	146	1,044	1	92	2	2	5	0
Chlamydomonas,	0	18	11	0	0	0	0	0	0	0	0	0
Epistylis,	0	0	0	0	0	32	0	0	0	0	0	0
Peridinium,	0	2	1	0	26	1,010	0	92	2	2	0	0
Uroglena,	1	0	0	0	120	0	0	0	0	0	0	0
Vermes,	2	2	0	2	12	3	1	8	0	0	1	0
Crustacea,	0	0	0	0	0	0	pr.	0	0	0	pr.	pr.
Cyclops,	0	0	0	0	0	0	pr.	0	0	0	pr.	pr.
Daphnia,	0	0	0	0	0	0	0	0	0	0	0	pr.
Miscellaneous, Zoöglœa,	3	10	10	5	10	3	3	0	0	3	5	3
TOTAL,	141	189	244	2,321	9,520	1,308	321	3,708	2,270	693	928	842

Water Supply of Worcester.

Chemical Examination of Water from Lynde Brook Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29963	Jan. 16	Slight.	V. slight.	.30	4.20	1.50	.0042	.0198	.0172	.0026	.20	.0020	.0001	.44	1.3
30250	Feb. 20	Slight.	Slight.	.36	3.15	1.40	.0048	.0210	.0172	.0038	.11	.0060	.0002	.59	0.5
30645	Mar. 20	V. slight.	V. slight.	.26	2.05	0.85	.0006	.0150	.0120	.0030	.16	.0070	.0000	.40	0.5
31029	Apr. 17	Slight.	Slight.	.20	2.35	0.95	.0012	.0168	.0138	.0030	.11	.0050	.0000	.39	0.3
31269	May 15	V. slight.	Slight.	.14	2.25	0.90	.0008	.0142	.0130	.0012	.13	.0020	.0000	.35	0.5
31809	June 20	Slight.	Cons.	.21	3.00	1.95	.0022	.0198	.0162	.0036	.12	.0010	.0000	.42	0.5
32066	July 17	V. slight.	Slight.	.12	2.65	1.30	.0008	.0150	.0140	.0010	.12	.0010	.0000	.39	0.6
32595	Aug. 22	V. slight.	V. slight.	.13	2.50	1.00	.0004	.0188	.0174	.0014	.13	.0010	.0000	.40	0.6
32983	Sept. 18	V. slight.	Slight.	.22	2.90	1.05	.0060	.0224	.0178	.0046	.12	.0020	.0000	.36	0.6
33334	Oct. 17	V. slight.	Slight.	.29	3.10	1.30	.0128	.0164	.0156	.0008	.13	.0020	.0001	.38	1.0
33649	Nov. 13	V. slight.	Slight.	.25	3.35	1.35	.0114	.0158	.0148	.0010	.16	.0050	.0001	.34	1.0
34030	Dec. 11	V. slight.	V. slight.	.33	3.50	1.40	.0066	.0168	.0154	.0014	.21	.0130	.0001	.54	1.4

Averages by Years.

-	1888	-	-	.24	2.64	0.85	.0037	.0151	-	-	.14	.0065	.0001	-	-
-	1889	-	-	.24	2.54	0.60	.0030	.0167	.0138	.0029	.15	.0053	.0001	-	-
-	1890	-	-	.21	3.07	1.15	.0026	.0132	.0107	.0025	.14	.0078	.0001	-	0.9
-	1891	-	-	.24	2.83	1.03	.0045	.0126	.0101	.0025	.12	.0074	.0001	-	0.7
-	1892	-	-	.25	2.99	1.15	.0038	.0139	.0113	.0026	.15	.0105	.0000	-	0.8
-	1893	-	-	.26	2.66	0.98	.0036	.0162	.0122	.0039	.15	.0066	.0001	.35	0.6
-	1894	-	-	.36	3.37	1.09	.0055	.0139	.0117	.0022	.18	.0103	.0000	.35	1.2
-	1895	-	-	.32	3.63	1.30	.0033	.0161	.0138	.0023	.20	.0116	.0000	.45	1.2
-	1896	-	-	.29	2.95	1.27	.0035	.0158	.0133	.0025	.18	.0054	.0000	.38	0.8
-	1897	-	-	.44	3.31	1.25	.0068	.0191	.0164	.0027	.18	.0087	.0001	.42	0.8
-	1898	-	-	.31	3.24	1.32	.0030	.0156	.0140	.0016	.20	.0059	.0001	.38	0.8
-	1899	-	-	.20	2.49	1.06	.0030	.0147	.0130	.0017	.12	.0031	.0000	.31	0.4
-	1900	-	-	.23	2.92	1.25	.0043	.0176	.0153	.0023	.14	.0039	.0000	.42	0.7

Note to analyses of 1900: Odor, generally vegetable or none, occasionally unpleasant. A fishy odor was observed in the second sample on heating.

WORCESTER.

Microscopical Examination of Water from Lynde Brook Storage Reservoir.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	17	21	21	18	16	21	19	23	19	18	15	13
Number of sample,	29963	30250	30645	31029	31269	31809	32066	32595	32983	33334	33649	34030
PLANTS.												
Diatomaceæ,	0	6	1	50	163	72	8	144	20	17	40	34
Cyclotella,	0	0	0	0	0	19	4	108	14	2	11	2
Synedra,	0	0	1	3	110	11	1	1	0	2	0	1
Cyanophyceæ,	0	0	0	1	0	25	0	0	0	1	0	0
Anabæna,	0	0	0	0	0	17	0	0	0	0	0	0
Algæ,	0	12	0	1	10	124	0	28	1	9	0	0
Protococcus,	0	12	0	0	6	112	0	27	0	8	0	0
ANIMALS.												
Infusoria,	43	53	17	46	5	71	13	9	2	14	1	3
Dinobryon,	8	17	0	42	0	70	2	8	0	13	0	0
Peridinium,	35	31	12	2	0	0	10	1	0	0	0	3
Uroglena,	0	3	4	0	0	0	0	0	0	0	1	0
Vermes,	0	0	0	1	0	1	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	3	3	3	3	5	5	3	5	3	3	3	5
TOTAL,	46	74	21	102	183	298	24	186	26	44	44	42

Chemical Examination of Water from Kent Reservoir on Kettle Brook, in Leicester

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
29962	Jan. 16	V. slight.	V. slight.	.23	3.40	1.15	.0078	.0152	.0136	.0016	.19	.0060	.0001	.44	0.8
30249	Feb. 20	Slight.	V. slight.	.34	2.90	1.30	.0058	.0238	.0210	.0028	.14	.0050	.0002	.57	0.3
30646	Mar. 20	Slight.	Slight.	.33	2.15	0.95	.0016	.0170	.0146	.0024	.15	.0010	.0000	.48	0.3
31030	Apr. 17	Slight.	Slight.	.14	2.60	0.85	.0030	.0170	.0150	.0020	.15	.0120	.0000	.37	0.5
31268	May 15	Slight.	Cons.	.19	2.75	1.00	.0014	.0190	.0146	.0044	.18	.0010	.0001	.43	0.5
31808	June 20	Slight.	Slight.	.32	3.00	1.25	.0042	.0296	.0244	.0052	.13	.0040	.0000	.43	0.6
32065	July 17	V. slight.	V. slight.	.34	3.10	1.20	.0060	.0212	.0192	.0020	.11	.0020	.0002	.54	0.6
32594	Aug. 22	V. slight.	V. slight.	.21	2.90	1.25	.0006	.0208	.0170	.0038	.13	.0010	.0000	.36	1.0
32982	Sept. 18	Slight.	Cons.	.62	2.90	1.00	.0064	.0324	.0262	.0062	.14	.0030	.0000	.53	0.8
33333	Oct. 17	V. slight.	Slight.	.30	3.60	1.20	.0036	.0212	.0160	.0052	.22	.0100	.0001	.43	1.1
33648	Nov. 13	Decided.	Cons.	.40	4.90	1.30	.0012	.0224	.0194	.0030	.25	.0110	.0000	.66	1.6
34029	Dec. 11	V. slight	V. slight	.45	4.20	1.60	.0032	.0160	.0150	.0010	.22	.0210	.0000	.66	1.7

WORCESTER.

Chemical Examination of Water from Kent Reservoir on Kettle Brook, in Leicester — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
-	1898	-	-	.36	3.20	1.40	.0012	.0176	.0150	.0026	.16	.0042	.0001	.46	0.8
-	1899	-	-	.27	3.25	1.39	.0047	.0239	.0195	.0044	.13	.0037	.0001	.47	0.7
-	1900	-	-	.32	3.20	1.17	.0037	.0213	.0180	.0033	.17	.0064	.0001	.49	0.8

NOTE to analyses of 1900: Odor, vegetable or none, occasionally becoming unpleasant on heating.

Chemical Examination of Water from Bottomly Pond on Kettle Brook, in Paxton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29964	Jan. 16	Slight.	V. slight.	0.34	4.90	1.65	.0110	.0172	.0164	.0008	.21	.0070	.0001	0.56	1.4
30251	Feb. 20	Decided.	V. slight.	0.40	2.65	1.35	.0066	.0216	.0174	.0042	.10	.0060	.0002	0.59	0.3
30647	Mar. 20	V. slight.	V. slight.	0.30	1.95	1.00	.0010	.0140	.0132	.0008	.10	.0020	.0000	0.53	0.2
31031	Apr. 17	Slight.	Slight.	0.21	2.55	1.05	.0032	.0208	.0164	.0044	.11	.0060	.0000	0.44	0.3
31270	May 15	V. slight.	Slight.	0.28	2.40	0.95	.0018	.0186	.0152	.0034	.12	.0010	.0001	0.49	0.5
31810	June 20	V. slight.	Slight.	0.37	3.00	1.50	.0030	.0200	.0188	.0012	.11	.0010	.0000	0.61	0.5
32067	July 17	V. slight.	Slight.	0.44	3.00	1.25	.0065	.0305	.0285	.0020	.12	.0010	.0002	0.63	0.6
32596	Aug. 22	Slight.	Cons.	1.30	4.35	2.35	.0140	.0396	.0382	.0014	.11	.0030	.0001	0.73	0.6
32984	Sept. 18	Decided.	Heavy.	0.35	4.00	1.20	.0230	.0680	.0184	.0496	.15	.0040	.0001	0.34	0.8
33335	Oct. 17	V. slight.	Cons.	0.53	5.65	1.80	.0088	.0332	.0244	.0088	.18	.0060	.0001	0.84	1.8
33650	Nov. 13	Decided.	Cons.	0.95	6.00	2.70	.0010	.0380	.0292	.0088	.22	.0200	.0001	1.21	1.4
34031	Dec. 11	Decided.	Cons.	0.60	4.10	1.70	.0028	.0204	.0162	.0042	.17	.0100	.0000	0.77	1.3
Av...	....	....	....	0.51	3.71	1.54	.0069	.0285	.0210	.0075	.14	.0056	.0001	0.64	0.8

Odor, vegetable or none.

WORCESTER.

Chemical Examination of Water from Tatnuck Brook Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
29961	Jan. 16	V. slight.	V. slight.	.17	2.80	1.00	.0052	.0174	.0150	.0024	.21	.0010	.0000	.31	0.6
30248	Feb. 20	Slight.	V. slight.	.32	2.10	1.05	.0060	.0194	.0150	.0044	.10	.0000	.0000	.46	0.5
30644	Mar. 20	V. slight.	V. slight.	.20	1.80	0.80	.0006	.0112	.0102	.0010	.12	.0050	.0000	.35	0.2
31028	Apr. 17	Slight.	Slight.	.12	1.80	0.75	.0012	.0196	.0164	.0032	.10	.0030	.0000	.33	0.0
31267	May 15	Slight.	Slight.	.13	1.85	0.55	.0010	.0140	.0118	.0022	.10	.0010	.0000	.27	0.2
31807	June 20	Slight.	Slight.	.16	2.45	1.50	.0006	.0142	.0124	.0018	.10	.0060	.0000	.52	0.2
32064	July 17	V. slight.	V. slight.	.11	2.95	1.10	.0012	.0136	.0120	.0016	.09	.0010	.0001	.31	0.2
32593	Aug. 22	V. slight.	V. slight.	.08	2.70	1.00	.0002	.0136	.0118	.0018	.12	.0020	.0000	.28	0.2
32981	Sept. 18	Slight.	Cons.	.16	2.10	0.85	.0032	.0212	.0122	.0090	.12	.0010	.0000	.22	0.2
33332	Oct. 17	Slight.	Cons.	.12	2.00	0.75	.0070	.0460	.0120	.0340	.13	.0010	.0001	.25	0.2
33647	Nov. 13	Decided.	Cons.	.09	2.25	0.85	.0020	.0184	.0130	.0054	.15	.0010	.0000	.26	0.3
34028	Dec. 11	V. slight.	V. slight.	.19	2.40	1.00	.0028	.0146	.0122	.0024	.13	.0060	.0001	.36	0.3

Averages by Years.

-	1888	-	-	.17	2.23	0.75	.0012	.0157	-	-	.12	.0043	.0001	-	-
-	1889	-	-	.19	2.04	0.57	.0003	.0143	.0112	.0031	.12	.0031	.0001	-	-
-	1890	-	-	.17	2.68	1.24	.0007	.0141	.0102	.0039	.13	.0078	.0001	-	0.9
-	1891	-	-	.17	2.30	0.94	.0024	.0143	.0102	.0041	.11	.0077	.0001	-	0.4
-	1892	-	-	.20	2.52	1.03	.0012	.0142	.0113	.0029	.12	.0067	.0000	-	0.5
-	1893	-	-	.35	2.45	0.93	.0020	.0182	.0140	.0042	.14	.0049	.0000	.36	0.5
-	1894	-	-	.20	2.27	0.85	.0010	.0151	.0114	.0037	.16	.0032	.0000	.30	0.4
-	1895	-	-	.21	2.33	0.98	.0012	.0173	.0130	.0043	.18	.0068	.0000	.36	0.5
-	1896	-	-	.17	2.00	0.84	.0008	.0142	.0109	.0033	.15	.0034	.0000	.27	0.4
-	1897	-	-	.21	2.12	0.82	.0007	.0155	.0125	.0030	.16	.0054	.0000	.30	0.5
-	1898	-	-	.22	2.24	0.96	.0006	.0141	.0114	.0027	.16	.0020	.0000	.30	0.5
-	1899	-	-	.11	2.00	0.80	.0013	.0136	.0106	.0030	.13	.0016	.0000	.23	0.2
-	1900	-	-	.15	2.27	0.93	.0026	.0186	.0128	.0058	.12	.0023	.0000	.33	0.3

NOTE to analyses of 1900: Odor, generally none. On heating, the odor of most of the samples was faintly vegetable, and in April also fishy.

WORCESTER.

Microscopical Examination of Water from Tatnuck Brook Storage Reservoir.

[Number of organisms per cubic centimeter.]

	1900.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	17	21	21	18	16	21	19	23	19	18	15	13
Number of sample,	29961	30248	30644	31028	31267	31807	32064	32593	32981	33332	33647	34028
PLANTS.												
Diatomaceæ,	20	12	0	282	2,094	76	47	83	88	756	1,261	240
Asterionella,	8	1	0	80	62	51	3	29	24	84	56	12
Melosira,	4	9	0	184	1,932	0	0	0	44	588	862	129
Synedra,	0	0	0	0	0	0	2	0	2	20	50	24
Tabellaria,	8	1	0	16	100	24	42	54	18	50	290	73
Cyanophyceæ,	0	0	0	0	0	0	0	0	0	4	3	0
Algæ,	0	0	0	0	14	0	0	24	2	28	19	8
ANIMALS.												
Infusoria,	31	3	50	572	6	3	1	28	6	2	9	9
Dinobryon,	0	0	43	538	6	0	0	18	1	2	5	8
Euglena,	0	1	1	16	0	0	1	0	0	0	0	1
Mallomonas,	20	0	1	6	0	0	0	0	0	0	1	0
Peridinium,	11	2	3	8	0	1	0	10	5	0	0	0
Uroglena,	0	0	2	0	0	1	0	0	0	0	1	0
Vermes,	0	0	1	2	0	7	0	1	0	2	1	1
Crustacea, Cyclops,	0	0	0	0	0	0	pr.	0	0	0	0	0
Miscellaneous, Zoöglœa,	0	8	3	7	10	5	3	3	10	20	8	5
TOTAL,	51	23	54	863	2,124	91	51	139	106	812	1,301	263

EXAMINATION OF RIVERS.

EXAMINATION OF RIVERS.

During the year 1900 examinations have been made monthly of the waters of the Assabet, Blackstone, Charles, Hoosick, Housatonic, Merrimack, Nashua, Neponset, Saugus, Sudbury and Westfield rivers and some of their principal tributaries, and during the summer months of the waters of the Chicopee, Connecticut, French, Millers, Nemasket, Quinebaug, Salisbury Plain, Shawsheen, Taunton and Ten Mile rivers and their principal tributaries. Occasional examinations have also been made of other streams in the State. The results of the examinations will generally be found arranged alphabetically by rivers in the pages which follow, but some of them are given on the preceding pages in the examinations of water supplies, as follows: —

	Page
Merrimack at Lowell,	203
Merrimack at Lawrence,	192
Nashua at Clinton,	112
Quinepoxet at Holden,	110
Saugus at Montrose,	213
Stillwater at Sterling,	111
Sudbury at Framingham,	122

The flow of streams for the year as a whole was about normal, but the distribution was very uneven. The flow during the spring was large, but during the remainder of the year the flow was exceptionally low.

Assabet River.

(For special examination of Assabet River, see *Concord River.*)

Chemical Examination of Water from Assabet River, below the Sewage Filtration Area at Westborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
30031	Jan. 22	Decided.	Slight.	0.98	6.10	2.80	.0320	.0404	.0372	.0032	.30	.0150	.0008	1.26	1.4
30407	Mar. 7	V slight.	V. slight.	0.37	3.30	1.45	.0008	.0132	.0124	.0008	.21	.0030	.0001	0.63	0.5
30621	Mar. 18	Slight.	Slight.	0.38	3.30	1.70	.0448	.0228	.0214	.0014	.28	.0050	.0006	0.60	0.5
31100	Apr. 26	V. slight.	V. slight.	1.20	4.70	2.60	.0006	.0340	.0326	.0014	.25	.0010	.0000	1.36	1.3
31381	May 23	V. slight.	Slight.	2.00	5.25	2.85	.0032	.0362	.0352	.0010	.25	.0110	.0008	1.69	1.6
31812	June 19	V. slight.	Cons.	1.20	5.65	3.00	.0120	.0495	.0460	.0035	.35	.0060	.0001	1.33	1.4
32283	July 25	Slight.	Cons.	0.85	6.75	2.65	.0108	.0440	.0392	.0048	.64	.0010	.0001	1.16	1.6
32657	Aug. 23	V. slight.	Slight.	0.36	6.30	1.85	.0076	.0324	.0280	.0044	.77	.0090	.0003	0.67	2.0
33035	Sept. 18	V. slight.	Slight.	0.24	6.30	1.65	.0052	.0236	.0228	.0008	.94	.0020	.0000	0.43	1.7
33389	Oct. 20	None.	V. slight.	0.49	7.05	2.30	.0060	.0336	.0296	.0040	.58	.0120	.0000	0.73	2.0
33911	Dec. 1	V. slight.	V. slight.	0.90	6.00	2.90	.0118	.0332	.0312	.0020	.26	.0050	.0000	1.29	2.1
Av.*.	....	....	....	0.86	5.74	2.42	.0112	.0345	.0319	.0026	.46	.0066	.0002	1.05	1.6

Odor, vegetable or unpleasant, becoming stronger, and occasionally musty, on heating. —— The samples were collected from the river, at the bridge on Belmont Street, about 1,000 feet below the filter beds of the town of Westborough.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Chemical Examination of Water from Assabet River, below Hudson.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
32313	July 30	Decided.	Cons.	.56	8.25	1.85	.0062	.0528	.0416	.0112	1.52	.0010	.0004	0.87	2.0
32501	Aug. 15	Slight.	Slight.	.54	5.30	1.50	.0100	.0392	.0340	.0052	0.52	.0000	.0003	0.59	1.8
32689	Aug. 27	Decided.	Cons	.42	8.10	1.95	.0560	.0524	.0396	.0128	2.17	.0040	.0009	0.57	2.0
32704	Aug. 29	Decided.	Heavy.	.70	12.45	2.45	.0640	.1110	.0630	.0480	2.49	.0020	.0001	1.34	2.3
33121	Sept. 27	Slight.	Cons.	.46	10.65	2.75	.0832	.0544	.0380	.0164	1.64	.0000	.0007	0.67	2.1
33461	Oct. 24	V. slight.	Cons.	.34	6.35	1.60	.0496	.0336	.0292	.0044	0.80	.0030	.0016	0.57	2.0
33805	Nov. 26	Decided.	Cons.	.50	6.40	2.10	.0085	.0420	.0265	.0155	0.66	.0080	.0004	0.68	1.8
33879	Dec. 3	V. slight.	Slight.	.70	6.35	2.30	.0080	.0344	.0294	.0050	0.76	.0040	.0002	1.03	2.1
Av.*.	....	....	....	.52	7.77	2.09	.0331	.0474	.0350	.0124	1.18	.0030	.0006	0.77	2.0

Odor, generally unpleasant, sometimes vegetable or musty, becoming stronger on heating. —— The samples were collected from the river, at O'Neil bridge, so called, about a mile below the village of Hudson.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

ASSABET RIVER.

Chemical Examination of Water from Assabet River, below Maynard.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
32033	July 16	Slight.	Cons.	0.41	4.95	1.65	.0244	.0348	.0268	.0080	.57	.0010	.0001	.59	1.3
32502	Aug. 15	Decided.	Slight.	0.30	5.35	1.65	.0140	.0376	.0264	.0112	.67	.0000	.0002	.50	1.1
32585	Aug. 22	Decided.	Heavy.	2.10	7.00	2.05	.1340	.0610	.0380	.0230	.65	.0010	.0000	.60	1.4
32732	Aug. 29	Decided.	Cons.	0.34	6.15	1.70	.0090	.0425	.0335	.0090	.76	.0010	.0003	.49	1.1
33051	Sept. 24	Decided.	Slight.	0.35	5.15	1.50	.0046	.0300	.0248	.0052	.67	.0010	.0001	.49	1.3
33408	Oct. 24	Decided.	Cons.	0.36	5.25	1.35	.0128	.0396	.0340	.0056	.81	.0030	.0005	.64	1.7
33701	Nov. 19	Decided.	Slight.	0.45	7.10	2.35	.0145	.0415	.0336	.0079	.78	.0100	.0003	.71	1.6
34125	Dec. 18	Decided.	Slight.	0.64	5.50	2.50	.0046	.0260	.0232	.0028	.47	.0330	.0000	.88	1.6
Av*..	....	....	....	0.52	5.69	1.86	.0189	.0365	.0292	.0073	.66	.0081	.0002	.64	1.4

Odor, disagreeable or unpleasant, usually becoming stronger on heating.—— The samples were collected from the river, near the works of the American Powder Company.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Blackstone River.

The regular monthly examinations of the water of the Blackstone River have been continued as in previous years and the results are given in the tables which follow. The first of the tables is taken from a report of the superintendent of sewers of the city of Worcester for the year ending March 31, 1901, and contains the monthly averages of analyses made by the city of samples of sewage and effluent collected at the Worcester Precipitation Works, and the percentage of matters removed by treatment at these works. According to the above-mentioned report there were treated during the year ending Nov. 30, 1900, an average of about 13,100,000 gallons per day of mingled sewage and brook water taken from the Mill Brook channel, a small portion of this being passed through sand filters after sedimentation without the use of chemicals. The effluent from the precipitation works and from the filter beds, and the excess of flow of Mill Brook over the amount treated, were discharged into the Blackstone River. The second and third tables show the averages for each year since 1887 and for the six dry months of each year of chemical analyses of samples collected at various points along the river.

BLACKSTONE RIVER.

WORCESTER SEWAGE PURIFICATION WORKS.

Abstract of Analyses of Sewage and Effluent made by the City of Worcester.

[Taken from the annual report of the superintendent of sewers of the city of Worcester for the year ending March 31, 1901.]

[Parts per 100,000.]

DATE OF COLLECTION.	Ammonia.				Oxygen Consumed.		
		Albuminoid.					
	Free.	Total.	Dissolved.	Suspended.	Unfiltered.	Filtered.	Chlorine.
Sewage, December, 1899,	2.266	.766	.384	.382	9.62	6.35	8.53
Effluent, December, 1899,	1.765	.335	.332	.003	4.92	4.92	8.62
Per cent. removed,	22.11	56.27	13.54	99.15	48.85	22.52	—1.05
Sewage, January, 1900,	1.589	.539	.262	.277	7.61	6.59	7.89
Effluent, January, 1900,	1.246	.239	.234	.005	5.07	5.07	8.03
Per cent. removed,	21.58	55.65	10.69	98.19	33.37	23.06	—1.77
Sewage, February, 1900,	1.100	.544	.269	.275	7.32	4.48	5.24
Effluent, February, 1900,	.806	.231	.222	.009	3.84	3.84	5.20
Per cent. removed,	26.73	56.43	17.47	96.67	59.85	14.29	0.76
Sewage, March, 1900,	.639	.403	.172	.231	4.87	3.13	4.70
Effluent, March, 1900,	.596	.177	.168	.009	2.39	2.39	4.53
Per cent. removed,	6.73	56.08	.233	96.12	50.93	23.64	3.62
Sewage, April, 1900,	.905	.507	.265	.242	6.02	3.34	5.48
Effluent, April, 1900,	.795	.251	.245	.006	3.13	3.13	5.40
Per cent. removed,	12.15	50.49	7.55	97.52	48.00	6.29	1.46
Sewage, May, 1900,	.775	.385	.202	.183	5.55	3.18	5.28
Effluent, May, 1900,	.750	.173	.170	.003	2.72	2.72	5.22
Per cent. removed,	3.23	55.05	15.84	98.35	50.99	14.45	1.14
Sewage, June, 1900,	.906	.456	.238	.218	5.84	3.32	6.25
Effluent, June, 1900,	1.006	.231	.213	.018	2.96	2.96	6.45
Per cent. removed,	—11.04	49.34	10.50	91.73	49.32	10.84	—3.20
Sewage, July, 1900,	1.538	.559	.309	.250	7.20	4.38	8.08
Effluent, July, 1900,	1.469	.328	.281	.047	3.77	3.77	8.22
Per cent. removed,	4.49	41.32	9.06	81.21	47.64	13.93	—1.73

BLACKSTONE RIVER.

WORCESTER SEWAGE PURIFICATION WORKS — *Concluded.*

[Parts per 100,000.]

DATE OF COLLECTION	Ammonia.				Oxygen Consumed.		Chlorine.
	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Unfiltered.	Filtered.	
Sewage, August, 1900,	1.331	.465	.202	.263	7.27	4.94	7.63
Effluent, August, 1900,	1.238	.258	.249	.009	3.42	3.42	7.98
Per cent. removed,	6.99	44.51	—23.27	96.56	52.97	30.77	—4.59
Sewage, September, 1900,	1.344	.608	.220	.388	7.75	5.49	7.60
Effluent, September, 1900,	1.281	.286	.272	.014	3.95	3.95	7.65
Per cent. removed,	4.69	52.97	—23.60	96.40	49.00	28.05	—0.66
Sewage, October, 1900,	1.655	.698	.222	.476	8.81	6.78	6.46
Effluent, October, 1900,	1.445	.296	.288	.008	3.65	3.65	7.02
Per cent. removed,	12.69	57.58	—29.73	98.32	58.56	46.16	—8.67
Sewage, November, 1900,	1.394	.700	.214	.486	7.87	5.62	6.10
Effluent, November, 1900,	1.300	.315	.305	.010	4.13	4.13	5.92
Per cent. removed,	6.74	55.00	—42.52	97.95	47.52	26.52	2.95
Sewage for year ending Dec. 1, 1900,	1.292	.551	.244	.306	7.18	4.82	6.64
Effluent for year ending Dec. 1, 1900,	1.137	.258	.247	.011	3.65	3.65	6.70
Per cent. removed,	11.99	53.18	—1.23	96.40	49.17	24.28	—0.90

NOTE.— Monthly averages are made from daily analyses of sewage and effluent. The daily sewage samples consist of forty-eight portions taken half hourly. Sewage samples are taken as nearly as possible in proportion to the amount of sewage being received at the time of the sampling. Effluent samples consist of twenty-four portions taken hourly.

BLACKSTONE RIVER.

Averages of Chemical Analyses of Water from the Blackstone River for the Years 1888 to 1900, inclusive.

Blackstone River between Mill Brook Channel and the Sewage Precipitation Works.

[Parts per 100,000.]

YEAR.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
1888,	0.64	-	-	.2112	.1040	-	-	1.21	.0370	.0029	-
1889,	0.76	-	-	.2841	.1198	.0629	.0569	1.06	.0235	.0024	-
1890,	0.82	-	-	.1800	.1024	.0549	.0475	1.03	.0367	.0014	-
1891,	0.80	13.54	4.00	.3340	.1563	.0840	.0723	1.73	.0333	.0032	4.6
1892,	0.71	16.28	4.85	.2530	.1262	.0627	.0635	1.84	.0312	.0061	4.9
1893,	0.68	17.95	4.88	.1429	.0603	.0325	.0277	1.04	.0180	.0012	4.5
1894,	0.86	17.17	5.58	.0739	.0570	.0304	.0266	0.88	.0195	.0006	3.7
1895,	0.84	13.40	4.02	.0507	.0374	.0229	.0145	0.86	.0175	.0007	2.9
1896,	0.75	12.69	3.37	.0759	.0486	.0309	.0177	1.01	.0187	.0010	2.9
1897,	0.94	17.62	5.31	.0715	.0533	.0306	.0227	0.77	.0151	.0015	2.9
1898,	0.50	13.52	4.34	.0762	.0557	.0259	.0298	0.83	.0167	.0011	3.5
1899,	0.26	25.33	8.08	.1921	.0751	.0360	.0391	1.20	.0109	.0010	9.7
1900,	0.18	19.49	5.44	.1141	.0602	.0253	.0349	0.83	.0102	.0011	6.2

Blackstone River below Sewage Precipitation Works.

YEAR.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
1888,	0.64	-	-	.2112	.1040	-	-	1.21	.0370	.0029	-
1889,	0.76	-	-	.2841	.1198	.0629	.0569	1.06	.0235	.0024	-
1890,	0.74	-	-	.2253	.1177	.0581	.0596	1.26	.0381	.0016	-
1891,	0.80	15.62	4.52	.4080	.1303	.0695	.0608	1.91	.0358	.0031	4.6
1892,	0.53	19.35	5.29	.3633	.1442	.0737	.0705	2.21	.0278	.0033	7.2
1893,	0.74	25.65	6.54	.3757	.1447	.0864	.0583	1.98	.0369	.0070	7.4
1894,	0.60	25.75	6.61	.4228	.1309	.0946	.0363	2.13	.0316	.0047	7.9
1895,	0.79	19.14	4.78	.2298	.0840	.0573	.0267	1.52	.0347	.0040	5.8
1896,	0.40	24.28	6.36	.2645	.0930	.0615	.0315	1.91	.0356	.0071	8.3
1897,	0.75	19.94	4.59	.2447	.0843	.0630	.0213	1.33	.0300	.0047	5.4
1898,	0.49	19.41	5.20	.2260	.0725	.0473	.0252	1.30	.0264	.0072	6.6
1899,	0.30	32.48	7.90	.3908	.1337	.0749	.0588	2.37	.0176	.0053	12.0
1900,	0.25	22.47	4.48	.4430	.1249	.0621	.0628	2.13	.0110	.0145	7.3

Blackstone River at Uxbridge.

YEAR.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
1888,	0.45	-	-	.0979	.0284	-	-	0.61	.0322	.0008	-
1889,	0.28	-	-	.0992	.0300	.0191	.0109	0.60	.0253	.0009	-
1890,	0.25	-	-	.1168	.0214	.0152	.0062	0.66	.0272	.0006	-
1891,	0.27	8.32	1.94	.1647	.0272	.0197	.0075	0.77	.0396	.0008	2.8
1892,	0.21	8.59	1.90	.2113	.0222	.0153	.0069	0.82	.0326	.0007	2.8
1893,	0.40	9.45	1.91	.1603	.0256	.0167	.0089	1.00	.0424	.0029	3.2
1894,	0.51	10.80	1.97	.1372	.0242	.0187	.0055	1.22	.0460	.0032	4.0
1895,	0.64	10.56	2.44	.1081	.0315	.0243	.0072	1.05	.0439	.0037	3.9
1896,	0.42	10.77	2.50	.1209	.0308	.0249	.0059	1.09	.0405	.0054	4.2
1897,	0.59	10.31	2.50	.1126	.0298	.0248	.0050	1.04	.0481	.0035	3.8
1898,	0.58	8.72	2.30	.0818	.0305	.0232	.0073	0.84	.0360	.0046	3.2
1899,	0.26	14.06	2.51	.2298	.0374	.0297	.0077	1.59	.0331	.0078	5.6
1900,	0.27	11.43	1.97	.2122	.0351	.0262	.0089	1.38	.0359	.0039	4.2

Blackstone River at Millville.

YEAR.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
1888,	0.47	-	-	.0444	.0253	-	-	0.44	.0242	.0005	-
1889,	0.38	-	-	.0450	.0277	.0206	.0071	0.43	.0160	.0004	-
1890,	0.34	-	-	.0587	.0211	.0162	.0049	0.46	.0240	.0004	-
1891,	0.32	6.05	1.83	.0807	.0293	.0194	.0099	0.55	.0275	.0005	1.9
1892,	0.35	6.03	1.62	.0896	.0249	.0180	.0069	0.54	.0218	.0004	1.8
1893,	0.40	6.23	1.53	.0899	.0288	.0225	.0063	0.66	.0289	.0008	2.0
1894,	0.49	6.37	1.90	.0528	.0219	.0173	.0046	0.73	.0232	.0008	2.5
1895,	0.58	7.47	2.27	.0501	.0253	.0189	.0064	0.74	.0278	.0016	2.7
1896,	0.40	7.34	1.64	.0549	.0248	.0185	.0063	0.76	.0347	.0018	2.8
1897,	0.53	7.07	2.14	.0528	.0262	.0219	.0043	0.73	.0332	.0014	2.6
1898,	0.55	6.43	1.95	.0456	.0256	.0201	.0055	0.61	.0222	.0016	2.3
1899,	0.28	8.95	2.04	.0985	.0267	.0221	.0046	0.88	.0220	.0029	3.2
1900,	0.36	8.32	1.81	.1194	.0288	.0232	.0056	0.93	.0272	.0023	2.9

BLACKSTONE RIVER.

Averages of Chemical Analyses of Water from the Blackstone River for Six Months, from June to November, 1887 to 1900, inclusive.

Blackstone River between Mill Brook Channel and the Sewage Precipitation Works.

[Parts per 100,000.]

Months.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
June-Nov., 1887,	0.91	-	-	.2686	.1741	-	-	1.35	.0160	-	-
" " 1888,	0.76	-	-	.2658	.1112	.0557	.0555	1.50	.0382	.0041	-
" " 1889,	0.86	-	-	.3980	.1430	.0772	.0658	1.32	.0177	.0026	-
" " 1890,	1.14	9.92	3.03	.2107	.1246	.0673	.0573	1.07	.0250	.0015	2.9
" " 1891,	1.10	17.42	5.59	.4913	.1950	.1127	.0823	2.29	.0192	.0037	5.0
" " 1892,	0.52	20.75	6.30	.3547	.1433	.0708	.0725	2.43	.0227	.0108	6.1
" " 1893,	0.40	16.98	4.55	.1480	.0588	.0240	.0348	1.01	.0115	.0015	6.3
" " 1894,	0.66	16.93	4.76	.0548	.0380	.0236	.0144	0.74	.0115	.0005	4.4
" " 1895,	0.49	14.17	4.50	.0613	.0414	.0243	.0171	0.92	.0163	.0006	3.4
" " 1896,	0.51	12.90	2.93	.0780	.0415	.0282	.0133	0.97	.0147	.0015	3.4
" " 1897,	0.85	26.45	7.68	.1130	.0674	.0362	.0312	0.89	.0090	.0024	4.2*
" " 1898,	0.33	17.42	5.62	.0857	.0619	.0260	.0359	0.96	.0053	.0010	4.6
" " 1899,	0.14*	34.38	10.60	.2583	.0788	.0390	.0398	1.55†	.0050†	.0004	14.3
" " 1900,	0.05	16.48	3.38	.1068	.0518	.0210	.0308	1.03	.0107	.0012	3.6

Blackstone River below Sewage Precipitation Works.

Months.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
June-Nov., 1887,	0.91	-	-	.2686	.1741	-	-	1.35	.0160	-	-
" " 1888,	0.76	-	-	.2658	.1112	.0557	.0555	1.50	.0382	.0041	-
" " 1889,	0.86	-	-	.3980	.1430	.0772	.0658	1.32	.0177	.0026	-
" " 1890,	0.97	11.36	3.10	.2907	.1492	.0722	.0770	1.46	.0270	.0018	3.9
" " 1891,	1.05	22.25	6.60	.6367	.1508	.0883	.0625	2.61	.0233	.0040	6.2
" " 1892,	0.63	26.80	7.75	.5240	.1810	.0958	.0852	3.13	.0137	.0050	10.3
" " 1893,	0.51	30.00	7.13	.5680	.1453	.0900	.0553	2.76	.0285	.0126	10.9
" " 1894,	0.40	29.30	5.86	.6189	.1390	.1113	.0277	2.63	.0212	.0071	10.6
" " 1895,	0.71	22.15	5.18	.3246	.0898	.0597	.0301	1.86	.0267	.0063	7.3
" " 1896,	0.30	26.03	6.53	.2831	.0898	.0600	.0298	2.10	.0217	.0118	9.7
" " 1897,	0.73	25.98	4.97	.3650	.1122	.0782	.0340	1.61	.0207	.0063	6.9
" " 1898,	0.23	25.63	6.73	.3064	.0868	.0560	.0308	1.55	.0132	.0119	9.2
" " 1899,	0.14*	44.02	9.67	.5251	.1707	.0912	.0795	3.26	.0108*	.0068	16.1
" " 1900,	0.22	24.57	4.48	.4430	.1249	.0612	.0628	2.13	.0110	.0145	7.3

Blackstone River at Uxbridge.

Months.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
June-Nov., 1887,	0.39	-	-	.1129	.0271	-	-	0.79	.0360	-	-
" " 1888,	0.38	6.42	1.52	.1155	.0288	.0222	.0066	0.68	.0310	.0007	-
" " 1889,	0.32	-	-	.1133	.0296	.0192	.0104	0.66	.0333	.0009	-
" " 1890,	0.26	8.86	2.12	.1629	.0231	.0174	.0057	0.79	.0259	.0005	2.9
" " 1891,	0.20	10.16	2.61	.2280	.0175	.0117	.0058	1.04	.0425	.0007	3.6
" " 1892,	0.13	9.36	1.88	.2840	.0227	.0162	.0065	0.99	.0313	.0007	3.1
" " 1893,	0.24	11.74	2.37	.1985	.0207	.0140	.0067	1.20	.0623	.0050	4.2
" " 1894,	0.35	13.07	2.03	.1456	.0243	.0183	.0060	1.57	.0673	.0050	4.9
" " 1895,*	0.56	12.95	2.69	.0906	.0258	.0182	.0076	1.34	.0631	.0065	4.7
" " 1896,	0.33	12.68	2.67	.1129	.0257	.0221	.0036	1.38	.0477	.0091	5.0
" " 1897,	0.48	11.60	2.47	.1029	.0280	.0215	.0065	1.32	.0652	.0051	4.3
" " 1898,	0.49	10.59	2.78	.0801	.0264	.0219	.0045	1.00	.0470	.0076	3.8
" " 1899,	0.18	18.34	3.11	.2490	.0359	.0310	.0049	2.17	.0510	.0141	7.4
" " 1900,	0.19	13.42	2.04	.2260	.0347	.0257	.0090	1.76	.0558	.0060	5.0

Blackstone River at Millville.

Months.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
June-Nov., 1887,	0.31	-	-	.0468	.0220	-	-	0.51	.0210	-	-
" " 1888,	0.41	5.22	1.40	.0467	.0296	.0233	.0063	0.50	.0278	.0004	-
" " 1889,	0.38	-	-	.0499	.0273	.0213	.0060	0.45	.0167	.0003	-
" " 1890,	0.26	6.71	2.24	.0736	.0196	.0152	.0044	0.53	.0229	.0003	2.3
" " 1891,	0.24	7.48	2.35	.1105	.0384	.0234	.0150	0.72	.0308	.0006	2.2
" " 1892,	0.37	6.70	1.62	.1143	.0294	.0210	.0084	0.63	.0217	.0002	2.0
" " 1893,	0.23	7.43	1.73	.0677	.0119	.0087	.0031	0.77	.0385	.0011	2.6
" " 1894,	0.47	8.42	2.16	.0510	.0172	.0139	.0033	0.89	.0273	.0012	2.8
" " 1895,	0.51	8.67	2.55	.0356	.0233	.0180	.0053	0.90	.0383	.0024	3.2
" " 1896,	0.35	8.53	1.69	.0484	.0237	.0180	.0057	0.97	.0413	.0027	3.3
" " 1897,	0.45	7.66	1.98	.0509	.0258	.0210	.0048	0.92	.0445	.0019	3.1
" " 1898,	0.51	7.12	2.17	.0325	.0240	.0193	.0047	0.63	.0240	.0023	2.5
" " 1899,	0.20	12.50	2.44	.1310	.0301	.0247	.0054	1.31	.0310	.0049	4.6
" " 1900,	0.29	9.33	1.82	.1168	.0254	.0219	.0035	1.15	.0417	.0039	3.4

* Average of five months. † Average of two months.

BLACKSTONE RIVER.

Chemical Examination of Water from Blackstone River, between

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance.			Residue on Evaporation.					
						Total Residue.			Loss on Ignition.		
			Turbidity.	Sediment.	Color.	Total.	Dis-solved.	Sus-pended.	Total.	Dis-solved.	Sus-pended.
		1900.									
1	29995	Jan. 18	Decided.	Heavy.	.12	37.80	23.10	14.70	11.80	6.10	5.70
2	30303	Feb. 24	Decided.	Cons.	.75	6.40	5.10	1.30	2.20	1.60	0.60
3	30718	Mar. 23	Decided.	Heavy.	.02	16.10	9.15	6.95	4.20	2.15	2.05
4	31055	Apr. 20	Decided.	Heavy.	.38	11.20	4.60	6.60	2.80	1.30	1.50
5	31284	May 16	Decided.	Heavy.	–	39.20	34.90	4.30	16.45	12.65	3.80
6	31935	July 2	Decided.	Heavy.	.03	15.40	9.30	6.10	2.20	1.40	0.80
7	32082	July 18	Decided.	Heavy.	.00	14.60	12.15	2.45	3.40	1.90	1.50
8	32717	Aug. 29	Decided.	Heavy.	.03	14.70	12.85	1.85	2.80	1.60	1.20
9	32976	Sept. 18	Decided.	Heavy.	.09	24.70	12.80	11.90	5.70	2.05	3.65
10	33337	Oct. 17	Slight	Heavy.	.14	14.30	10.90	3.40	2.40	1.55	0.85
11	33672	Nov. 13	Decided.	Heavy.	.02	15.20	10.25	4.95	3.80	1.90	1.90
12	34140	Dec. 18	Decided.	Heavy.	.38	24.30	20.10	4.20	7.50	3.35	4.15
13	Av....	....	....	....	.18	19.49	13.77	5.72	5.44	3.13	2.31

Odor, distinctly unpleasant or disagreeable, sometimes musty.—— The samples were collected from 34140 on Tuesday, No. 29995 on Thursday, Nos. 30718 and 31055 on Friday, No. 30303 on Saturday, and

Chemical Examination of Water from Blackstone River,

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance.			Residue on Evaporation.					
						Total Residue.			Loss on Ignition.		
			Turbidity.	Sediment.	Color.	Total.	Dis-solved.	Sus-pended.	Total.	Dis-solved.	Sus-pended.
		1900.									
1	29996	Jan. 18	Decided.	Heavy.	0.09	47.20	35.40	11.80	12.00	7.80	4.20
2	30304	Feb. 24	Decided.	Cons.	1.20	9.00	6.70	2.30	2.60	1.60	1.00
3	30719	Mar. 23	Decided.	Heavy.	0.02	10.70	7.75	2.95	3.15	1.80	1.35
4	31056	Apr. 20	Decided.	Heavy.	0.30	19.40	6.80	12.60	6.20	2.00	4.20
5	31285	May. 16	Decided.	Heavy.	0.04	17.15	13.35	3.80	4.25	2.35	1.90
6	31936	July 2	Decided.	Heavy.	0.41	19.40	17.00	2.40	3.30	2.20	1.10
7	32083	July 18	Decided.	Heavy.	0.01	17.30	13.90	3.40	3.30	2.00	1.30
8	32718	Aug. 29	Decided.	Heavy.	0.30	28.20	26.20	2.00	4.50	3.55	0.95
9	32977	Sept. 18	Decided.	Heavy.	0.23	37.50	22.50	15.00	7.70	3.60	4.10
10	33338	Oct. 17	Decided.	Heavy.	0.23	20.00	15.15	4.85	3.80	1.75	2.05
11	33673	Nov. 13	Decided.	Heavy.	0.14	25.00	22.15	2.85	4.30	3.85	0.45
12	34141	Dec. 18	Decided.	Heavy.	0.02	18.80	13.25	5.55	5.10	2.85	2.25
13	Av....	....	....	....	0.25	22.47	16.68	5.79	5.02	2.95	2.07

Odor, distinctly unpleasant or offensive.—— The samples were collected from the river, above enters the river. No. 31285 was collected on Monday, Nos. 32977 and 34141 on Tuesday, No. 29996 on The samples were collected between 9.05 and 11.30 A.M.

BLACKSTONE RIVER.

Mill Brook Channel and the Worcester Sewage Precipitation Works.

[Parts per 100,000.]

Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.		Hardness.	Iron.		
	Albuminoid.											
Free.	Total.	Dis-solved.	Sus-pended.		Nitrates.	Nitrites.	Un-filtered.	Filtered.		Unfiltered.	Filtered.	
.1040	.1300	.0240	.1060	–	–	.0012	3.28	1.11	12.6	4.6000	2.4000	1
.0160	.0295	.0230	.0065	0.31	.0060	.0003	0.76	0.62	1.3	0.1960	0.0660	2
.0440	.0280	.0160	.0120	–	–	.0006	0.84	0.49	5.0	1.3000	0.6000	3
.0240	.0525	.0170	.0355	0.35	.0120	.0007	1.15	0.48	1.6	0.3560	0.0460	4
.2400	.1100	.0660	.0440	–	–	.0017	4.98	3.00	23.0	2.3200	0.5000	5
.0940	.0440	.0180	.0260	0.92	.0020	.0006	0.82	0.34	3.6	0.7100	0.0210	6
.0850	.0330	.0185	.0145	0.70	.0030	.0003	0.80	0.49	4.9	1.2000	0.7500	7
.1080	.0410	.0230	.0180	–	–	.0005	0.75	0.50	3.6	1.6000	0.0200	8
.2000	.1020	.0315	.0705	1.64	.0110	.0040	1.48	0.46	3.6	0.7800	0.0780	9
.1000	.0390	.0180	.0210	0.93	–	.0010	0.73	0.40	2.7	1.3200	0.3400	10
.0540	.0520	.0170	.0350	0.95	.0270	.0009	0.92	0.43	3.3	0.7600	0.2600	11
.3000	.0620	.0320	.0300	–	–	.0014	1.72	1.07	9.3	1.9200	0.2500	12
.1141	.0602	.0253	.0349	0.83	.0102	.0011	1.52	0.78	6.2	1.4218	0.4442	13

the river, about 200 feet below the iron bridge. No. 31935 was collected on Monday, Nos. 32976 and the other samples on Wednesday. The samples were collected between 8.45 and 11.15 A.M.

below the Worcester Sewage Precipitation Works.

[Parts per 100,000.]

Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.		Hardness.	Iron.		
	Albuminoid.											
Free.	Total.	Dis-solved.	Sus-pended.		Nitrates.	Nitrites.	Un-filtered.	Filtered.		Unfiltered.	Filtered.	
.3280	.1640	.0720	.0920	–	–	.0024	3.08	1.56	20.0	4.4000	2.7200	1
.0235	.0440	.0270	.0170	0.38	.0100	.0006	0.83	0.61	2.6	0.2720	0.1240	2
.1700	.0910	.0430	.0480	0.93	.0300	.0013	1.02	0.49	5.6	0.8200	0.0080	3
.0450	.1450	.0240	.1210	0.44	.0180	.0018	2.12	0.56	4.4	1.2000	0.0490	4
.2400	.0670	.0250	.0420	1.54	.0230	.0019	0.80	0.64	5.6	1.0400	0.3300	5
.5600	.0980	.0600	.0380	2.27	.0110	.0600	1.02	0.74	7.3	0.2400	0.0380	6
.4000	.0525	.0260	.0265	1.21	.0040	.0017	0.72	0.43	4.6	0.8000	0.0120	7
.6200	.1040	.0830	.0210	3.13	.0050	.0180	0.85	0.73	8.9	0.7400	0.1480	8
.4700	.2200	.0715	.1485	2.63	.0030	.0000	2.50	0.86	9.3	1.1600	0.0600	9
.2520	.0710	.0360	.0350	1.55	.0090	.0025	0.88	0.51	5.4	0.8800	0.0360	10
.3560	.2040	.0960	.1080	2.00	.0340	.0048	1.80	0.98	8.3	1.4800	0.0200	11
.2800	.0840	.0360	.0480	1.19	.0840	.0025	1.68	0.59	4.4	1.0400	0.0700	12
.3120	.1120	.0500	.0620	1.57	.0210	.0081	1.44	0.72	7.2	1.1727	0.3012	13

Millbury and below the point where the effluent from the Worcester Sewage Precipitation Works Thursday, Nos. 30719 and 31056 on Friday, No. 30304 on Saturday, and the other samples on Wednesday.

BLACKSTONE RIVER.

Chemical Examination of Water from Blackstone River, at Uxbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29999	Jan. 19	Decided.	Cons.	.06	16.55	3.15	.4800	.0470	.0400	.0070	1.84	.0100	.0036	.41	5.7
30263	Feb. 21	Decided.	Cons.	.68	7.70	2.05	.0800	.0435	.0300	.0135	0.70	.0060	.0010	.41	2.1
30714	Mar. 22	Decided.	Cons.	.50	4.60	1.40	.0270	.0350	.0280	.0070	0.34	.0120	.0003	.48	2.2
31046	Apr. 19	Decided.	Cons.	.31	8.70	1.60	.1800	.0220	.0185	.0035	0.88	.0080	.0014	.30	3.3
31328	May 19	Decided.	Cons.	.32	8.60	1.60	.2040	.0240	.0160	.0080	1.07	.0200	.0018	.31	3.3
31818	June 21	Decided.	Cons.	.11	8.60	1.95	.0720	.0500	.0260	.0240	0.99	.0520	.0034	.35	3.3
32089	July 19	Slight.	Slight.	.13	12.30	2.20	.1900	.0285	.0240	.0045	1.59	.0240	.0120	.46	4.9
32526	Aug. 16	Slight.	Cons.	.18	12.25	2.25	.1040	.0350	.0240	.0110	1.64	.0800	.0090	.34	4.4
33025	Sept. 21	Slight.	Slight.	.19	16.75	2.00	.2480	.0288	.0236	.0052	2.48	.0960	.0070	.36	6.4
33393	Oct. 22	Slight.	Slight.	.20	16.40	1.90	.3720	.0336	.0284	.0052	2.09	.0480	.0033	.34	5.6
33785	Nov. 22	Decided.	Cons.	.34	14.25	1.95	.3700	.0320	.0280	.0040	1.80	.0350	.0014	.43	5.3
34189	Dec. 20	Decided.	Cons.	.25	10.50	1.65	.2200	.0420	.0280	.0140	1.17	.0400	.0025	.45	3.5
Av...	....	....	....	.27	11.43	1.97	.2122	.0351	.0262	.0089	1.38	.0359	.0039	.39	4.2

Odor, vegetable or unpleasant, occasionally musty and disagreeable, becoming stronger on heating. —— The samples were collected from the canal leading from the upper dam of the Calumet Woolen Company to the mill, just before the water passed the screens.

Chemical Examination of Water from Blackstone River, at Millville, Blackstone.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29982	Jan. 18	Decided.	Slight.	.28	15.80	3.05	.3800	.0490	.0390	.0100	1.71	.0070	.0022	.62	5.7
30262	Feb. 21	Decided.	Slight.	.70	6.10	1.85	.0540	.0330	.0220	.0110	0.49	.0070	.0003	.49	1.7
30715	Mar. 22	Decided.	Slight.	.44	4.00	1.50	.0210	.0320	.0240	.0080	0.28	.0070	.0002	.48	1.3
31043	Apr. 19	Decided.	Slight.	.38	6.00	1.60	.0940	.0210	.0190	.0020	0.63	.0110	.0006	.35	2.0
31278	May 16	Decided.	Cons.	.33	5.35	1.20	.0530	.0280	.0170	.0110	0.51	.0110	.0005	.43	1.7
31822	June 21	Slight.	Cons.	.33	7.80	3.00	.0880	.0250	.0210	.0040	0.64	.0350	.0040	.42	2.1
32088	July 19	Slight.	Slight.	.23	9.95	1.50	.1200	.0310	.0255	.0055	1.29	.0320	.0100	.40	3.9
32500	Aug. 15	Slight.	Slight.	.33	8.00	1.40	.0496	.0260	.0202	.0058	0.98	.0450	.0050	.41	3.3
33015	Sept. 20	V. slight.	Cons.	.26	10.60	1.75	.0832	.0220	.0208	.0012	1.51	.0580	.0017	.33	3.6
33382	Oct. 22	Slight.	Slight.	.30	10.00	1.75	.1600	.0232	.0216	.0016	1.28	.0400	.0017	.36	3.8
33784	Nov. 22	Decided.	Slight.	.30	9.65	1.55	.2000	.0250	.0225	.0025	1.18	.0400	.0009	.36	4.0
34188	Dec. 20	Slight.	Slight.	.44	6.60	1.55	.1300	.0300	.0260	.0040	0.70	.0330	.0011	.46	2.0
Av...	....	....	....	.36	8.32	1.81	.1194	.0288	.0232	.0056	0.93	.0272	.0023	.43	2.9

Odor, generally unpleasant, becoming stronger on heating. —— The samples were collected from the river, just above the dam in the village of Millville.

Charles River.

Chemical Examination of Water from Charles River, below Milford.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1900.														
32123	July 23	Decided.	Cons.	.73	5.75	2.50	0.0736	.0632	.0484	.0148	0.84	.0020	.0006	1.15	1.0
32787	Sept. 4	Decided.	Heavy.	.78	20.40	2.70	0.0824	.1476	.0956	.0520	6.69	.0020	.0001	0.82	3.1
32946	Sept. 17	Decided.	Cons.	.70	17.00	3.00	1.2600	.0995	.0670	.0325	3.43	.0020	.0040	0.93	5.0
33299	Oct. 15	Slight.	Cons.	.52	14.10	2.60	0.3920	.0424	.0392	.0032	2.33	.0380	.0140	0.76	4.3
34201	Dec. 24	V. slight.	Slight.	.54	4.75	1.50	0.0014	.0176	.0140	.0036	0.41	.0660	.0000	0.58	1.3
Av*.	....	....	....	.63	10.82	2.36	0.2845	.0617	.0457	.0160	2.16	.0270	.0041	0.84	2.6

Odor of the last sample, none, becoming faintly vegetable on heating; of the others, distinctly disagreeable or musty. —— The samples were collected from the river, below the point where the sewage from the town enters the stream.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Chemical Examination of Water from Charles River, at Needham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1900.														
29940	Jan. 15	Decided.	V. slight.	0.41	5.85	1.85	.0012	.0228	.0204	.0024	.46	.0110	.0001	0.61	1.7
30232	Feb. 19	Decided.	Slight.	0.68	4.60	1.90	.0006	.0268	.0248	.0020	.28	.0040	.0001	0.83	0.6
30637	Mar. 20	Slight.	Slight.	0.46	3.25	1.40	.0002	.0190	.0164	.0026	.31	.0010	.0001	0.63	1.0
31006	Apr. 15	V. slight.	V. slight.	0.50	4.15	1.75	.0004	.0210	.0200	.0010	.35	.0030	.0002	0.79	1.1
31239	May 14	V. slight.	Slight.	1.10	4.30	1.60	.0008	.0252	.0238	.0014	.30	.0010	.0000	0.90	1.1
31510	June 11	V. slight.	Slight.	1.20	4.75	2.25	.0016	.0324	.0290	.0034	.30	.0020	.0000	1.22	1.0
31960	July 9	V. slight.	V. slight.	0.59	4.25	1.65	.0006	.0258	.0244	.0014	.32	.0050	.0000	0.70	1.4
32451	Aug. 13	V. slight.	V. slight.	0.45	4.50	1.65	.0008	.0224	.0216	.0008	.42	.0010	.0000	0.66	1.1
32850	Sept. 10	V. slight.	V. slight.	0.32	4.70	1.25	.0010	.0222	.0210	.0012	.50	.0020	.0000	0.48	1.1
33208	Oct. 8	None.	Slight.	0.36	4.95	1.40	.0006	.0220	.0208	.0012	.53	.0040	.0001	0.49	1.3
33553	Nov. 5	None.	V. slight.	0.70	6.40	1.90	.0020	.0248	.0236	.0012	.58	.0060	.0001	0.71	1.6
33889	Dec. 3	None.	Slight.	0.76	6.10	2.30	.0020	.0312	.0256	.0056	.47	.0090	.0001	1.25	1.7
Av...	....	....	....	0.63	4.82	1.74	.0010	.0246	.0226	.0020	.40	.0041	.0001	0.77	1.2

Odor, generally vegetable, sometimes musty and unpleasant, becoming stronger on heating. —— The samples were collected from the river, at Dedham Avenue bridge.

CHARLES RIVER.

Chemical Examination of Water from Charles River, opposite the Filter-gallery of the Brookline Water Works, at West Roxbury.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29951	Jan. 15	Slight.	V. slight.	0.40	5.80	1.85	.0032	.0246	.0220	.0026	.45	.0100	.0002	0.64	2.0
30253	Feb. 20	Slight.	V. slight.	0.61	4.25	1.95	.0014	.0290	.0258	.0032	.27	.0010	.0002	0.87	0.8
30633	Mar. 19	V. slight.	V. slight.	0.50	3.40	1.50	.0006	.0192	.0176	.0016	.32	.0010	.0001	0.64	0.6
31019	Apr. 16	V. slight	V. slight.	0.58	3.95	1.75	.0010	.0220	.0216	.0004	.35	.0040	.0001	0.72	1.1
31786	June 19	V. slight.	V. slight.	1.12	5.00	2.25	.0012	.0320	.0290	.0030	.34	.0010	.0001	1.08	1.3
32098	July 20	V. slight.	V. slight.	0.50	4.30	1.35	.0022	.0268	.0246	.0022	.37	.0010	.0000	0.68	1 3
32563	Aug. 20	V. slight.	V. slight.	0.40	4.65	1.50	.0006	.0222	.0202	.0020	.46	.0010	.0000	0.61	1.3
33058	Sept. 24	V. slight.	V. slight.	0.30	4.60	1.00	.0010	.0206	.0184	.0022	.54	.0010	.0000	0.44	1.3
33588	Nov. 5	V. slight.	V. slight.	0.48	6.25	1.90	.0040	.0242	.0224	.0018	.58	.0060	.0001	0.70	1.7
34213	Dec. 24	None.	V. slight.	0.64	5.50	1.85	.0042	.0240	.0224	.0016	.44	.0270	.0001	0.83	1.8
Av...	....	....	....	0.55	4.77	1.69	.0019	.0245	.0224	.0021	.41	.0053	.0001	0.72	1.3

Odor, vegetable or none. A vegetable odor was developed in all of the samples on heating.

Chemical Examination of Water from Charles River, opposite the Well of the Waltham Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29966	Jan. 17	Slight.	V. slight.	0.40	6.65	2.15	.0060	.0270	.0250	.0020	.52	.0110	.0002	0.63	2.0
30256	Feb. 21	Slight.	V. slight.	0.59	4.60	2.00	.0024	.0302	.0268	.0034	.29	.0050	.0002	0.83	1.0
30675	Mar. 21	Slight.	V. slight.	0.45	3.55	1.55	.0006	.0250	.0192	.0058	.33	.0040	.0000	0.63	0.8
31004	Apr. 13	V. slight.	Slight.	0.48	4.50	1.80	.0022	.0250	.0238	.0012	.32	.0060	.0001	0.70	1.3
31275	May 16	V. slight.	V. slight.	1.10	4.90	2.00	.0040	.0350	.0302	.0048	.34	.0040	.0000	1.05	1.8
31790	June 20	Slight.	Slight.	1.15	5.40	2.50	.0076	.0378	.0366	.0012	.33	.0060	.0003	0.86	1.4
32304	July 31	Slight.	V. slight.	0.49	5.50	1.50	.0026	.0274	.0252	.0022	.47	.0000	.0001	0.55	1.8
32862	Sept. 10	V. slight.	V. slight.	0.33	5.55	1.35	.0062	.0264	.0238	.0026	.55	.0010	.0001	0.44	1.4
33081	Sept. 26	V. slight.	V. slight.	0.34	5.70	1.50	.0076	.0246	.0224	.0022	.56	.0040	.0002	0.41	1.6
33412	Oct. 24	V. slight.	Slight.	0.36	6.90	1.40	.0076	.0276	.0238	.0038	.60	.0140	.0002	0.54	1.7
33832	Nov. 28	Decided.	Slight.	0.44	6.55	1.85	.0066	.0256	.0238	.0018	.65	.0170	.0001	0.69	2.2
34197	Dec. 24	Slight.	V. slight.	0.70	6.75	2.50	.0074	.0338	.0314	.0024	.52	.0050	.0001	0.85	1.7
Av.*.	....	....	....	0.59	5.54	1.88	.0049	.0291	.0263	.0028	.45	.0068	.0001	0.70	1.6

Odor, generally vegetable, sometimes unpleasant and musty, becoming stronger on heating.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Chicopee River.

Chemical Examination of Water from the Quaboag River, above Palmer.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
32075	July 17	V. slight.	Slight.	.44	4.10	1.55	.0040	.0196	.0180	.0016	.19	.0010	.0001	.48	1.1
32614	Aug. 21	Slight.	Slight.	.51	4.70	1.45	.0032	.0236	.0202	.0034	.25	.0010	.0001	.60	1.0
32993	Sept. 19	V. slight.	V. slight.	.35	4.25	1.50	.0028	.0208	.0176	.0032	.28	.0030	.0001	.41	1.3
33486	Oct. 29	Slight.	V. slight.	.44	4.50	1.35	.0048	.0248	.0202	.0046	.31	.0040	.0002	.49	1.4
33741	Nov. 20	Slight.	Slight.	.43	4.45	1.20	.0036	.0216	.0160	.0056	.29	.0110	.0000	.46	1.7
34179	Dec. 18	Slight.	Slight.	.45	4.25	1.50	.0010	.0198	.0154	.0044	.25	.0100	.0003	.60	1.1
Av...	....	....	....	.44	4.37	1.42	.0032	.0217	.0179	.0038	.26	.0050	.0001	.51	1.3

Odor of the last sample, none, becoming faintly unpleasant on heating; of the others, faintly vegetable, becoming stronger on heating.

Chemical Examination of Water from the Quaboag River, below Palmer.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
32076	July 17	V. slight.	Slight.	.41	4.10	1.60	.0040	.0180	.0152	.0028	.18	.0030	.0001	.48	1.3
32615	Aug. 21	Slight.	Cons.	.50	5.15	2.50	.0044	.0246	.0200	.0046	.24	.0050	.0001	.57	0.8
32994	Sept. 19	V. slight.	V. slight.	.31	4.40	1.40	.0008	.0198	.0178	.0020	.30	.0050	.0001	.41	1.3
33487	Oct. 29	Slight.	Slight.	.40	4.70	1.25	.0048	.0248	.0194	.0054	.31	.0040	.0002	.49	1.0
33742	Nov. 20	Decided.	Cons.	.37	4.45	1.15	.0048	.0216	.0158	.0058	.29	.0140	.0000	.44	1.6
34180	Dec. 18	Slight.	Slight.	.41	4.35	1.55	.0008	.0190	.0148	.0042	.25	.0120	.0003	.55	1.1
Av...	....	....	....	.40	4.52	1.57	.0033	.0213	.0172	.0041	.26	.0072	.0001	.49	1.2

Odor, generally faintly vegetable, becoming stronger on heating.

CHICOPEE RIVER.

Chemical Examination of Water from Swift River, at Barrett's Junction.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.	Albuminoid.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
32045	July 16	V. slight.	Slight.	.31	3.50	1.05	.0010	.0164	.0138	.0026	.16	.0010	.0000	.49	1.1
32616	Aug. 23	Slight.	Cons.	.30	3.00	1.05	.0002	.0192	.0156	.0036	.15	.0010	.0001	.42	1.1
34193	Dec. 21	V. slight.	Slight.	.34	3.50	1.35	.0024	.0144	.0132	.0012	.17	.0100	.0000	.56	0.8
Av...	....	....	....	.32	3.33	1.15	.0012	.0167	.0142	.0025	.16	.0040	.0000	.49	1.0

Odor, vegetable. —— The samples were collected from the river, near site of old bridge, back of pulp mill.

Chemical Examination of Water from Ware River, at Cold Brook Station, Barre.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.	Albuminoid.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
31443	June 4	Slight	Cons.	0.69	3.55	1.55	.0004	.0218	.0192	.0026	.10	.0010	.0001	0.88	0.6
31921	July 2	Slight.	Slight.	0.77	3.95	2.00	.0026	.0242	.0222	.0020	.10	.0010	.0001	1.23	0.6
32388	Aug. 6	Slight.	V. slight.	0.45	3.35	1.30	.0016	.0224	.0202	.0022	.15	.0000	.0001	0.55	0.3
32794	Sept. 4	Slight.	Slight.	0.39	3.10	1.30	.0010	.0210	.0190	.0020	.14	.0020	.0000	0.55	0.5
33157	Oct. 1	V. slight.	V. slight.	0.32	3.35	1.20	.0024	.0196	.0176	.0020	.18	.0020	.0000	0.49	0.6
33617	Nov. 11	V. slight.	Slight.	1.00	4.85	2.40	.0064	.0288	.0232	.0056	.20	.0020	.0000	1.34	0.5
33958	Dec. 6	None.	Slight.	0.70	3.50	1.75	.0028	.0208	.0172	.0036	.11	.0020	.0000	0.94	0.5

Averages by Years.

-	1894	-	-	0.74	3.55	1.47	.0005	.0179	.0155	.0024	.14	.0023	.0000	0.63	0.8
-	1895	-	-	0.78	3.96	1.70	.0014	.0219	.0199	.0020	.17	.0051	.0000	0.79	0.9
-	1896	-	-	0.72	3.36	1.52	.0003	.0198	.0177	.0021	.11	.0038	.0000	0.73	0.8
-	1897	-	-	0.83	3.60	1.55	.0010	.0193	.0173	.0020	.14	.0032	.0000	0.69	0.7
-	1898	-	-	0.76	3.51	1.67	.0011	.0196	.0177	.0019	.14	.0027	.0000	0.76	0.7
-	1899	-	-	0.50	3.38	1.51	.0010	.0184	.0167	.0017	.14	.0032	.0000	0.60	0.4
-	1900	-	-	0.62	3.66	1.64	.0025	.0227	.0198	.0029	.14	.0014	.0000	0.85	0.5

NOTE to analyses of 1900: Odor in September, none; in December, distinctly unpleasant; at other times, faintly vegetable, becoming stronger on heating. —— The samples were collected from the river, at the railroad bridge, near Cold Brook station, in the south-easterly part of the town of Barre.

CHICOPEE RIVER.

Chemical Examination of Water from Ware River, below Ware.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
32061	July 17	Slight.	Cons.	.41	4.65	1.25	.0060	.0312	.0208	.0104	.21	.0000	.0008	.65	1.0
32605	Aug. 22	Decided.	Cons.	.37	4.50	1.40	.0032	.0324	.0248	.0076	.22	.0040	.0002	.53	0.8
33016	Sept. 20	Decided.	Cons.	.34	5.20	1.50	.0076	.0404	.0294	.0110	.33	.0020	.0003	.56	1.1
33322	Oct. 16	V. slight.	Slight.	.73	5.40	2.20	.0052	.0288	.0244	.0044	.24	.0040	.0002	.95	1.1
33713	Nov. 19	Decided.	Cons.	.70	4.90	1.85	.0110	.0275	.0220	.0055	.25	.0050	.0001	.96	1.4
34165	Dec. 19	Decided.	Slight.	.50	5.10	2.05	.0132	.0288	.0190	.0098	.25	.0120	.0002	.73	1.1
Av...	....	....	....	.51	4.96	1.71	.0077	.0315	.0234	.0081	.25	.0045	.0003	.73	1.1

Odor of the first sample, none; of the others, vegetable or unpleasant, becoming stronger on heating.

Chemical Examination of Water from Chicopee River, below Ludlow.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
32032	July 16	Slight.	Cons.	.40	4.40	1.50	.0038	.0236	.0184	.0052	.24	.0010	.0001	.42	1.3
32569	Aug. 20	Slight.	Cons.	.32	3.85	0.90	.0044	.0214	.0176	.0038	.23	.0030	.0001	.45	1.0
33053	Sept. 24	Slight.	Slight.	.30	5.35	1.40	.0034	.0222	.0174	.0048	.33	.0060	.0003	.35	1.4
33516	Oct. 30	Slight.	Cons.	.43	5.25	1.90	.0060	.0304	.0248	.0056	.32	.0050	.0003	.66	1.1
33710	Nov. 19	Decided.	Cons.	.50	4.75	1.85	.0060	.0245	.0216	.0029	.28	.0090	.0001	.71	1.4
34194	Dec. 20	Slight.	Cons.	.34	4.00	1.35	.0018	.0216	.0158	.0058	.28	.0350	.0002	.56	1.0
Av...	....	....	....	.38	4.60	1.48	.0042	.0240	.0193	.0047	.28	.0098	.0002	.52	1.2

Odor, faintly vegetable or unpleasant, becoming stronger on heating.

CONCORD RIVER.

Concord River.

The following analyses of samples collected from the Concord
made in connection with an investigation of the sanitary condition
tion were given in a special report of the Board in 1901, House

Chemical Examinations of Water from the Sudbury

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.	
			Turbidity.	Sediment.	Color.	Cold.	Hot.	Total.	Loss on Ignition.
1	32508	1900. Aug. 15	V. slight.	V. slight.	.34	Faintly musty.	Distinctly musty.	4.00	1.40
2	32721	Aug. 29	V. slight.	V. slight.	.22	Distinctly vegetable.	Distinctly vegetable.	4.00	1.15
3	32722	Aug. 29	Decided.	Heavy.	.80	Distinctly musty and unpleasant.	Distinctly musty and unpleasant.	11.80	3.60
4	34929	1901. Feb. 27	Decided.	Cons.	-	Distinctly disagreeable.	Decidedly disagreeable.	16.25	5.15
5	32509	1900. Aug. 15	Decided.	Cons.	.61	Distinctly unpleasant.	Decidedly unpleasant, odor of hay.	9.05	2.85
6	32510	Aug. 15	Decided.	Cons.	.61	Distinctly unpleasant.	Decidedly unpleasant.	10.30	3.10
7	32723	Aug. 29	Decided.	Cons.	.33	Distinctly musty and unpleasant.	Distinctly musty and unpleasant.	9.25	2.45
8	34889	1901. Feb. 27	Decided.	Heavy.	.60	Distinctly unpleasant.	Distinctly disagreeable.	15.30	5.35
9	32724	1900. Aug. 29	Slight.	Slight.	.30	Faintly musty and unpleasant.	Faintly musty and unpleasant.	6.95	1.60
10	32511	Aug. 15	Slight.	Slight.	.30	Distinctly vegetable.	Decidedly vegetable.	7.45	1.80
11	32725	Aug. 29	Slight.	Slight.	.29	Distinctly vegetable.	Distinctly vegetable.	8.00	1.70
12	34917	1901. Feb. 27	Slight.	Slight.	.27	Distinctly unpleasant.	Distinctly unpleasant.	7.15	2.00

Concord River.

River and its main tributaries, the Sudbury and Assabet rivers, were
of the Sudbury and Concord rivers. The results of the investiga-
Document No. 1380.

River, between Saxonville and Farm Bridge, Wayland.

[Parts per 100,000.]

Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Source.	
	Albuminoid.									
Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.				
.0040	.0216	.0210	.0006	0.36	.0000	.0002	0.44	1.6	Dam above Saxonville Mills.	1
.0012	.0244	.0212	.0032	0.36	.0030	.0000	0.44	1.6	Dam above Saxonville Mills.	2
.0390	.1500	.0990	.0510	0.90	.0020	.0000	1.19	2.2	At Red bridge, 3,000 feet below dam.	3
.5040	.2720	.2120	.0600	1.11	.0200	.0013	2.37	2.7	Below Saxonville, 4,000 feet below dam.	4
.0110	.1000	.0615	.0385	0.73	.0010	.0007	0.99	2.0	Below Saxonville, 1,000 feet below lower bridge, 1 mile below dam.	5
.0140	.0850	.0630	.0220	0.69	.0010	.0004	1.09	2.2	At Stone bridge, 2.7 miles below dam.	6
.0300	.0600	.0468	.0132	0.87	.0020	.0004	0.64	2.6	At Stone bridge, 2.7 miles below dam.	7
.0940	.0940	.0740	.0200	1.68	.1020	.0070	1.17	2.9	At Stone bridge, 2.7 miles below dam.	8
.0136	.0336	.0280	.0056	0.80	.0020	.0000	0.42	2.6	Below outlet Hurd's Pond, 4.1 miles below dam.	9
.0136	.0292	.0266	.0026	0.63	.0010	.0004	0.44	2.5	At Farm bridge, 6 miles below dam.	10
.0032	.0376	.0328	.0048	0.83	.0010	.0003	0.51	2.6	At Farm bridge, 6 miles below dam.	11
.0172	.0206	.0160	.0046	0.68	.0420	.0018	0.42	2.5	At Farm bridge, 6 miles below dam.	12

CONCORD RIVER.

Chemical Examination of Water from the

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.	
			Turbidity.	Sediment.	Color.	Cold.	Hot.	Total.	Loss on Ignition.
		1900.							
1	32512	Aug. 15	Slight.	Slight.	.29	Distinctly vegetable.	Distinctly vegetable.	6.15	1.30
2	32726	Aug. 29	V. slight.	Slight.	.36	V. faintly vegetable.	Faintly vegetable.	6.25	1.80
		1901.							
3	34918	Feb. 27	V. slight.	Slight	.29	Distinctly unpleasant.	Decidedly unpleasant.	6.45	2.00
4	Av...	....	....	....	.31	....	....	6.28	1.70
		1900.							
5	32504	Aug. 15	V. slight.	Slight.	.30	Decidedly vegetable and woody.	Decidedly vegetable and woody.	5.60	1.45
6	32735	Aug. 29	V. slight.	Slight.	.23	V. faintly vegetable.	V. faintly vegetable.	5.80	1.55
7	Av...	....	....	....	.26	....	....	5.70	1.50
8	32503	Aug. 15	V. slight.	V. slight.	.30	Decidedly vegetable and woody.	Decidedly vegetable and woody.	5.40	1.25
9	32734	Aug. 29	V. slight.	V. slight.	.19	V. faintly unpleasant.	V. faintly unpleasant.	5.85	1.35
		1901.							
10	34910	Feb. 27	Slight.	Slight.	.36	Faintly unpleasant	Distinctly unpleasant and fishy.	7.15	2.05
11	Av...	....	....	....	.28	....	....	6.13	1.55
		1900.							
12	32505	Aug. 15	V. slight.	Slight.	.30	Distinctly vegetable.	Distinctly vegetable.	5.50	1.30
13	32736	Aug. 29	V. slight.	V. slight.	.22	None.	None.	5.90	1.60
		1901.							
14	34877	Feb. 26	Slight.	Slight.	.32	Faintly unpleasant.	Distinctly unpleasant.	6.45	2.10
15	34911	Feb. 27	Slight.	Cons.	.37	Faintly unpleasant.	Distinctly unpleasant.	6.50	2.10
16	Av...	....	....	....	.30	....	....	6.09	1.77

CONCORD RIVER.

Sudbury River, between Wayland and Concord.

[Parts per 100,000.]

Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Source.	
	Albuminoid.									
Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.				
.0072	.0246	.0208	.0038	.66	.0030	.0005	.40	2.2	Canal bridge.	1
.0046	.0258	.0224	.0034	.63	.0020	.0002	.44	2.3	Canal bridge.	2
.0244	.0214	.0182	.0032	.65	.0410	.0010	.41	2.2	Canal bridge.	3
.0121	.0239	.0205	.0034	.65	.0153	.0006	.42	2.2	- -	4
.0022	.0260	.0238	.0022	.56	.0000	.0004	.41	2.3	At Lee's bridge.	5
.0030	.0244	.0222	.0022	.68	.0020	.0000	.38	2.0	At Lee's bridge.	6
.0026	.0252	.0230	.0022	.62	.0010	.0002	.39	2.1	- -	7
.0026	.0226	.0200	.0026	.60	.0000	.0001	.40	2.0	At Heath's bridge.	8
.0024	.0222	.0198	.0024	.58	.0030	.0000	.37	1.8	At Heath's bridge.	9
.0142	.0250	.0210	.0040	.62	.0380	.0006	.49	2.0	At Heath's bridge.	10
.0064	.0233	.0203	.0030	.60	.0137	.0002	.42	1.9	- -	11
.0044	.0262	.0214	.0048	.58	.0000	.0002	.42	2.2	Near mouth, Concord.	12
.0034	.0222	.0210	.0012	.55	.0010	.0000	.39	2.1	Near mouth, Concord.	13
.0122	.0274	.0244	.0030	.60	.0290	.0005	.47	2.1	Near mouth, Concord.	14
.0144	.0284	.0214	.0070	.59	.0380	.0005	.46	2.1	Near mouth, Concord.	15
.0086	.0260	.0220	.0040	.58	.0170	.0003	.43	2.1	- -	16

CONCORD RIVER.

Chemical Examination of Water from

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.	
			Turbidity.	Sediment.	Color.	Cold.	Hot.	Total.	Loss on Ignition.
1	34913	1901. Feb. 27	Decided.	Cons.	.50	Decidedly unpleasant.	Decidedly unpleasant.	6.00	2.20
2	32501	1900. Aug. 15	Slight.	Slight.	.54	Faintly vegetable.	Decidedly vegetable.	5.30	1.50
3	32704	Aug. 29	Decided.	Heavy.	.70	Distinctly musty.	Decidedly musty.	12.45	2.45
4	34914	1901. Feb. 27	Decided.	Cons.	.33	Decidedly unpleasant.	Decidedly unpleasant.	8.05	2.30
5	34912	Feb. 27	Decided.	Slight.	.40	Decidedly unpleasant.	Decidedly unpleasant.	6.60	2.00
6	32502	1900. Aug. 15	Decided.	Slight.	.30	Faintly unpleasant.	Decidedly unpleasant.	5.35	1.65
7	32732	Aug. 29	Decided.	Cons.	.34	Faintly musty and unpleasant.	Faintly musty and unpleasant.	6.15	1.70
8	34908	1901. Feb. 27	Decided.	Cons.	.35	Decidedly unpleasant.	Distinctly disagreeable.	7.05	2.55
9	32507	1900. Aug. 15	Slight.	Cons.	.32	Faintly vegetable.	Distinctly vegetable and musty.	5.05	1.35
10	32737	Aug. 29	V. slight.	V. slight.	.24	None.	Faintly musty.	5.75	1.50
11	34876	1901. Feb. 26	Slight.	Cons.	.35	Distinctly unpleasant.	Decidedly unpleasant.	5.70	1.90
12	34907	Feb. 27	Slight.	Cons.	.35	Distinctly unpleasant.	Decidedly unpleasant.	6.30	2.10

Chemical Examination of Water from

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.	
			Turbidity.	Sediment.	Color.	Cold.	Hot.	Total.	Loss on Ignition.
1	32506	1900. Aug. 15	V. slight.	Slight.	0.32	Faintly vegetable.	Distinctly vegetable and faintly musty.	5.35	1.30
2	32733	Aug. 29	V. slight.	V. slight.	0.30	Faintly vegetable.	Faintly vegetable and musty.	5.50	1.35
3	34909	1901. Feb. 27	Slight.	Cons.	0.34	Distinctly unpleasant.	Decidedly unpleasant.	6.35	2.00
4	21264	1897. Nov. 16	V. slight.	Slight.	1.10	Faintly earthy.	Distinctly vegetable and musty.	5.90	2.70
5	32517	1900. Aug. 15	V. slight.	Slight.	0.26	Distinctly vegetable.	Distinctly unpleasant.	6.10	1.50
6	32739	Aug. 29	V. slight.	V slight.	0.20	None.	Very faintly unpleasant.	5.40	1.25
7	32738	Aug. 29	V. slight.	V. slight.	0.20	None.	None.	5.20	1.35

CONCORD RIVER.

the Assabet River, at Various Points.

[Parts per 100,000.]

Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Source.	
Free.	Albuminoid. Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.				
.0204	.0520	.0218	.0302	0.43	.0280	.0002	0.61	1.6	Two miles above Northborough.	1
.0100	.0392	.0340	.0052	0.52	.0000	.0003	0.59	1.8	Below Hudson.	2
.0640	.0110	.0630	.0480	2.49	.0020	.0001	1.34	2.3	Below Hudson.	3
.0256	.0416	.0304	.0112	1.59	.0300	.0005	0.65	1.8	Below Hudson.	4
.0188	.0336	.0274	.0062	0.71	.0230	.0005	0.53	1.4	Below Gleasondale.	5
.0140	.0376	.0264	.0112	0.67	.0000	.0002	0.50	1.1	Below Maynard.	6
.0090	.0425	.0335	.0090	0.76	.0010	.0003	0.49	1.1	Below Maynard.	7
.0288	.0480	.0372	.0108	0.71	.0200	.0004	0.61	1.6	Below Maynard.	8
.0216	.0388	.0234	.0154	0.65	.0070	.0007	0.43	1.3	Near mouth.	9
.0138	.0278	.0256	.0022	0.78	.0040	.0005	0.48	1.3	Near mouth.	10
.0164	.0308	.0242	.0066	0.66	.0260	.0004	0.51	1.8	Near mouth.	11
.0230	.0296	.0248	.0048	0.59	.0280	.0005	0.55	1.6	Near mouth.	12

the Concord River, at Various Points.

[Parts per 100,000.]

Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Source.	
Free.	Albuminoid. Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.				
.0102	.0286	.0228	.0058	.64	.0030	.0004	0.45	1.6	Below North bridge, Concord.	1
.0080	.0250	.0226	.0024	.67	.0040	.0003	0.45	1.7	At Flint's bridge, Concord.	2
.0158	.0278	.0212	.0066	.63	.0330	.0005	0.41	1.7	At junction with Assabet and Sudbury rivers, Concord.	3
.0030	.0352	.0326	.0026	.52	.0130	.0002	1.13	1.6	Below bridge near W. Hutchins's, Billerica.	4
.0044	.0224	.0204	.0020	.94	.0010	.0001	0.46	2.5	Above Billerica water works.	5
.0040	.0222	.0204	.0018	.59	.0010	.0000	0.43	1.4	At corner bridge, above North Billerica.	6
.0018	.0220	.0212	.0008	.59	.0010	.0000	0.42	1.4	Above Talbot Company's mill, Billerica.	7

CONNECTICUT RIVER.

Connecticut River.

Chemical Examination of Water from the Connecticut River, at Northfield Farms.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
32081	July 18	Slight.	Slight.	.28	6.05	2.10	.0012	.0156	.0144	.0012	.06	.0000	.0001	0.77	3.0
32559	Aug. 20	V. slight.	Slight.	.30	6.05	1.75	.0006	.0142	.0128	.0014	.08	.0040	.0003	0.79	3.3
32961	Sept. 17	V. slight.	Slight.	.24	7.10	1.45	.0006	.0114	.0098	.0016	.11	.0010	.0000	0.73	3.8
33308	Oct. 15	V. slight.	Cons.	.83	6.25	2.50	.0045	.0270	.0190	.0080	.08	.0050	.0000	1.16	2.2
33709	Nov. 19	Slight.	Slight.	.68	5.75	2.75	.0044	.0270	.0212	.0058	.10	.0050	.0001	1.29	2.1
34122	Dec. 17	V. slight.	Slight.	.24	6.05	1.90	.0024	.0148	.0134	.0014	.11	.0190	.0006	0.73	3.0
Av...	....	....	....	.43	6.21	2.07	.0023	.0183	.0151	.0032	.09	.0057	.0002	0.91	2.9

Odor of the first and last samples, none; of the others, faintly vegetable. An unpleasant odor was developed in two of the samples on heating.

Chemical Examination of Water from the Connecticut River, below Springfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
32049	July 17	V. slight.	Cons.	.25	6.10	1.50	.0112	.0184	.0144	.0040	.17	.0010	.0002	0.71	3.4
32546	Aug. 18	Slight.	Cons.	.24	6.15	1.05	.0112	.0148	.0128	.0020	.16	.0020	.0002	0.56	3.4
32967	Sept. 18	Decided.	Cons.	.29	7.85	2.05	.0156	.0280	.0184	.0096	.29	.0040	.0004	0.70	3.6
33347	Oct. 18	V. slight.	Cons.	.71	6.60	2.50	.0064	.0268	.0138	.0130	.17	.0020	.0002	1.17	2.5
33769	Nov. 21	Decided.	Cons.	.72	6.50	2.40	.0048	.0368	.0288	.0080	.20	.0080	.0002	1.33	2.7
34257	Dec. 29	Slight.	Slight.	.26	4.90	1.45	.0006	.0152	.0126	.0026	.18	.0090	.0001	0.58	2.5
Av...	....	....	....	.41	6.35	1.82	.0083	.0233	.0168	.0065	.19	.0043	.0002	0.84	3.0

Odor, generally faintly vegetable or unpleasant, becoming stronger on heating.—— The samples were collected from the river at the South End bridge, and were made up of portions taken at each pier of the bridge.

Deerfield River.

Chemical Examination of Water from the Deerfield River, at Colrain.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
34434	Jan. 10	V. slight	V. slight.	.08	4.80	1.85	.0018	.0096	.0082	.0014	.11	.0140	.0001	.26	2.3
34433	Jan. 10	V. slight.	V. slight.	.08	4.80	1.85	.0004	.0074	.0066	.0008	.11	.0180	.0000	.26	2.5

Odor, faintly vegetable, becoming stronger on heating. —— The first sample was collected from a pond at Willis Place, above Lyonsville, on the north branch of the Deerfield River; the last, from a mill-pond at Shattuckville, on the north branch of the Deerfield River.

French River.

Chemical Examination of Water from French River, below Webster.

[Parts per 100,000.]

Number	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
32021	July 13	Decided.	Cons.	.48	5.70	2.20	.0290	.0570	.0460	.0110	.45	.0010	.0018	.78	1.3
32551	Aug. 20	Slight.	Cons.	.60	5.75	1.70	.0236	.0368	.0300	.0068	.46	.0060	.0004	.71	1.8
32959	Sept. 18	Decided.	Cons.	.46	4.60	1.85	.0072	.0384	.0284	.0100	.36	.0030	.0002	.69	1.0
33698	Nov. 16	Decided.	Cons.	.53	7.10	2.65	.0210	.0580	.0385	.0195	.58	.0150	.0004	.95	1.8
Av...	....	....	....	.52	5.79	2.10	.0202	.0475	.0357	.0118	.46	.0062	.0007	.78	1.5

Odor of the first and last samples, unpleasant; of the second, distinctly vegetable; of the third, faintly musty, becoming stronger on heating. —— The samples were collected from the river, below the village of Webster, near the boundary line between the States of Massachusetts and Connecticut.

Hoosick River.

Chemical Examination of Water from the South Branch of the Hoosick River, near its Confluence with the North Branch at North Adams.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
31877	June 27	Decided.	Cons.	.10	17.00	4.45	.0150	.0390	.0210	.0180	.35	.0120	.0008	.28	7.3
32035	July 16	Slight.	Cons.	.10	13.35	2.25	.0256	.0300	.0172	.0128	.36	.0170	.0024	.22	7.7
32630	Aug. 23	Slight.	Cons.	.14	13.20	1.90	.0165	.0280	.0150	.0130	.30	.0190	.0025	.27	10.0
33123	Sept. 28	Slight.	Cons.	.15	14.65	2.50	.0125	.0325	.0182	.0143	.40	.0170	.0018	.28	11.2
33377	Oct. 22	Slight.	Cons.	.17	15.15	2.30	.0160	.0456	.0160	.0296	.42	.0450	.0048	.23	11.4
33762	Nov. 20	Decided.	Heavy.	.20	10.75	2.00	.0090	.0390	.0148	.0242	.28	.0220	.0006	.29	8.1
34235	Dec. 24	Decided.	Cons.	.25	6.55	1.65	.0090	.0495	.0195	.0300	.22	.0230	.0004	.54	4.2
Av...	....	....	....	.16	12.95	2.44	.0148	.0377	.0174	.0203	.33	.0221	.0019	.30	8.6

Odor, generally distinctly unpleasant.—— The samples were collected from the river, about a quarter of a mile above its confluence with the north branch.

Chemical Examination of Water from the North Branch of the Hoosick River, near its Confluence with the South Branch at North Adams.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
31876	June 27	Decided.	Cons.	0.45	15.35	3.65	.0140	.0520	.0220	.0300	0.85	.0010	.0017	1.24	7.0
32034	July 16	Decided.	Heavy.	–	14.20	3.60	.0015	.0495	.0240	.0255	0.99	.0010	.0140	1.26	6.1
32629	Aug. 23	Decided.	Heavy.	1.00	10.15	2.05	.0100	.0520	.0240	.0280	0.90	.0010	.0019	0.68	4.0
33122	Sept. 28	Decided.	Heavy.	–	34.55	9.20	.0030	.0980	.0480	.0500	2.38	.0040	.0002	3.02	11.2
33376	Oct. 22	Decided.	Heavy.	–	17.30	4.45	.0120	.0408	.0260	.0148	2.07	.0050	.0026	1.68	5.6
33761	Nov. 20	Decided.	Heavy.	0.52	6.20	2.00	.0032	.0316	.0172	.0144	0.22	.0070	.0003	0.68	2.3
34234	Dec. 24	Decided.	Cons.	0.30	4.75	1.40	.0090	.0300	.0128	.0172	0.19	.0160	.0001	0.56	1.8
Av...	....	....	....	0.57	14.64	3.76	.0075	.0506	.0249	.0257	1.09	.0050	.0030	1.30	5.4

Odor, distinctly unpleasant or disagreeable.—— The samples were collected from the river, about a quarter of a mile above its confluence with the south branch.

HOOSICK RIVER.

Chemical Examination of Water from the Hoosick River, at North Adams.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
31878	June 27	Decided.	Heavy.	–	28.55	10.20	0.9920	.3040	.1340	.1700	2.86	.0000	.0000	2.20	8.3
32036	July 16	Decided.	Heavy.	–	36.20	14.60	1.0200	.4260	.1500	.2760	4.89	.0010	.0000	2.36	7.6
32631	Aug. 23	Decided.	Heavy.	–	18.75	3.80	0.9800	.3860	.1470	.2390	2.93	.0040	.0000	1.58	6.7
33124	Sept. 28	Decided.	Heavy.	–	28.35	8.45	0.5400	.2550	.0560	.1990	3.06	.0020	.0000	1.98	9.1
33378	Oct. 22	Decided.	Heavy.	–	34.70	11.25	0.5600	.2980	.1870	.1110	2.98	.0050	.0035	2.50	11.4
33763	Nov. 20	Decided.	Heavy.	.45	7.70	1.90	0.0550	.1100	.0360	.0740	0.52	.0150	.0080	0.78	3.1
34236	Dec. 24	Decided.	Cons.	.32	6.00	1.70	0.0160	.0670	.0195	.0475	0.29	.0190	.0003	0.67	2.6
Av.	....	....	....	–	22.89	7.41	0.5947	.2637	.1042	.1595	2.50	.0066	.0017	1.72	7.0

Odor, distinctly disagreeable, becoming offensive on heating. —— The samples were collected from the river, near the barn of the North Adams Manufacturing Company in Braytonville, about three-quarters of a mile below the confluence of the north and south branches and below the point of discharge of the principal sewer in North Adams.

Chemical Examination of Water from the Hoosick River, at Williamstown.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29955	Jan. 16	Decided.	Heavy.	–	14.00	3.55	.0500	.0405	.0285	.0120	.62	.0220	.0012	.69	6.7
30261	Feb. 20	Decided.	Cons.	.21	9.15	2.65	.0272	.0252	.0208	.0044	.27	.0200	.0003	.64	4.6
30643	Mar. 20	Decided.	Heavy.	–	5.75	1.95	.0116	.0296	.0192	.0104	.16	.0070	.0003	.49	3.0
31023	Apr. 17	Slight.	Cons.	.11	4.90	1.40	.0015	.0145	.0090	.0055	.13	.0110	.0006	.35	3.0
31279	May 15	Decided.	Cons.	.10	10.20	2.00	.0160	.0445	.0210	.0235	.39	.0130	.0016	.35	6.6
31780	June 19	Decided.	Heavy.	.11	12.50	2.25	.0300	.0864	.0400	.0464	.67	.0060	.0060	.45	7.4
32048	July 17	Decided.	Cons.	.21	13.90	2.15	.1276	.0340	.0248	.0092	.59	.0110	.0072	.40	8.0
32576	Aug. 21	Decided.	Cons.	.30	11.90	2.45	.0106	.0200	.0120	.0080	.43	.0110	.0027	.54	6.1
32998	Sept. 18	Decided.	Cons.	–	18.45	3.50	.0435	.0600	.0380	.0220	.77	.0030	.0034	.68	8.4
33331	Oct. 16	Decided.	Cons.	.30	16.00	3.10	.0250	.0690	.0380	.0310	.75	.0000	.0045	.61	9.6
33685	Nov. 13	Decided.	Cons.	.50	12.45	3.30	.0230	.0590	.0280	.0310	.39	.0210	.0021	.83	7.1
34170	Dec. 18	Decided.	Cons.	.28	13.05	2.65	.0272	.0400	.0244	.0156	.48	.0500	.0016	.63	7.9

HOOSICK RIVER.

Chemical Examination of Water from the Hoosick River, at Williamstown — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
-	1888	-	-	.10	10.21	1.65	.0040	.0187	.0143	.0044	.24	.0306	.0010	-	-
-	1894	-	-	.23	10.77	2.13	.0111	.0265	.0169	.0096	.35	.0157	.0009	.34	7.3
-	1895	-	-	.28	12.41	2.95	.0146	.0334	.0207	.0127	.39	.0162	.0013	.46	8.1
-	1896	-	-	.21	11.83	2.91	.0261	.0326	.0217	.0109	.44	.0323	.0015	.44	8.1
-	1897	-	-	.23	9.92	2.16	.0125	.0273	.0169	.0104	.27	.0252	.0008	.31	6.4
-	1898	-	-	.24	9.13	2.20	.0152	.0286	.0180	.0106	.26	.0187	.0005	.32	5.8
-	1899	-	-	.28	12.37	2.95	.0223	.0505	.0308	.0197	.50	.0141	.0018	.53	6.9
-	1900	-	-	.24	11.85	2.58	.0328	.0436	.0253	.0183	.47	.0146	.0026	.55	6.5

NOTE to analyses of 1900: Odor, generally distinctly unpleasant, sometimes disagreeable and musty. —— The samples were collected from the river, at the bridge near the Williamstown station on the Fitchburg Railroad.

HOUSATONIC RIVER.

Chemical Examination of Water from the East Branch of the Housatonic River, at Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
31867	June 26	Slight.	Cons.	.24	9.25	1.75	.0192	.0264	.0192	.0072	.14	.0100	.0004	.40	5.6
32281	July 27	Decided.	Cons.	.22	10.15	2.15	.0128	.0416	.0312	.0104	.26	.0070	.0006	.42	7.0
32943	Sept. 14	Decided.	Cons.	.24	12.25	2.50	.0100	.0244	.0192	.0052	.31	.0060	.0009	.41	8.7
33071	Sept. 25	V. slight.	Cons.	.22	12.65	2.35	.0168	.0412	.0334	.0078	.30	.0100	.0007	.40	9.1
33433	Oct. 23	Slight.	Cons.	.30	13.55	2.65	.0196	.0464	.0396	.0068	.39	.0120	.0008	.48	9.7
33766	Nov. 20	Decided.	Cons.	.40	9.85	2.85	.0060	.0416	.0270	.0146	.24	.0190	0002	.86	6.3
34176	Dec. 18	Slight.	Cons.	.21	10.65	2.60	.0106	.0324	.0206	.0118	.23	.0310	.0006	.41	7.9
Av.*.	....	....	....	.27	10.98	2.40	.0136	.0369	.0273	.0096	.26	.0145	.0006	.49	7.6

Odor, generally musty or unpleasant. —— The samples were collected from the river, at Hathaway bridge, above the thickly settled portion of the city.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

HOUSATONIC RIVER.

Chemical Examination of Water from the West Branch of the Housatonic River, at Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
31866	June 26	Slight.	Cons.	.15	7.65	1.60	.0084	.0268	.0176	.0092	0.15	.0010	.0001	0.25	4.6
32280	July 27	Slight.	Cons.	.08	8.35	1.60	.0004	.0216	.0158	.0058	0.24	.0000	.0000	0.29	5.3
32942	Sept. 14	Decided.	Cons.	.15	9.25	1.85	.0008	.0432	.0198	.0234	0.28	.0020	.0000	0.35	6.3
33070	Sept. 25	Decided.	Cons.	.20	10.40	2.00	.0012	.0452	.0292	.0160	0.32	.0010	.0002	0.40	6.3
33432	Oct. 23	Decided.	Heavy.	-	45.80	13.75	.0970	.3260	.2290	.0970	1.56	.0010	.0000	2.64	8.9
33767	Nov. 20	Decided.	Heavy.	.21	11.20	1.50	.0080	.0410	.0196	.0214	0.22	.0060	.0003	0.35	6.0
34177	Dec. 18	Decided.	Cons.	.08	10.35	2.05	.0104	.0328	.0202	.0126	0.18	.0090	.0019	0.22	7.9
Av.*.	....	....	....	.14	15.53	3.74	.0209	.0821	.0545	.0276	0.44	.0031	.0004	0.69	6.5

Odor of the third sample, distinctly musty; of the others, faintly vegetable or unpleasant, generally becoming stronger on heating. —— The samples were collected from the river, a short distance below the junction of the brooks from Onota and Pontoosuc lakes No. 33432 was collected at a time when a large amount of waste matter was being discharged from the mills above the point of collection.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Chemical Examination of Water from the South-west Branch of the Housatonic River, at Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
31868	June 26	Slight.	Cons.	.09	9.65	1.70	.0372	.0376	.0232	.0144	.23	.0040	.0016	.33	6.1
32282	July 27	Slight.	Cons.	.14	13.75	2.00	.0100	.0212	.0170	.0042	.12	.0060	.0004	.31	10.3
32944	Sept. 14	Decided.	Cons.	.13	15.40	2.50	.0064	.0434	.0250	.0184	.18	.0020	.0012	.43	9.6
33072	Sept. 25	Decided.	Cons.	.12	14.40	2.20	.0092	.0440	.0320	.0120	.25	.0010	.0005	.35	9.4
33434	Oct. 23	Decided.	Slight.	.15	18.05	2.25	.0304	.0364	.0248	.0116	.26	.0080	.0007	.27	12.3
33768	Nov. 20	Decided.	Slight.	.20	18.00	2.45	.0108	.0284	.0212	.0072	.23	.0340	.0006	.43	12.6
34178	Dec. 18	None.	V. slight.	.06	11.65	2.05	.0036	.0072	.0068	.0004	.13	.0420	.0002	.13	9.7
Av.*.	....	....	....	.13	14.33	2.13	.0166	.0291	.0203	.0088	.20	.0159	.0007	.31	10.1

Odor of the last sample, none; of the others, faintly musty or unpleasant. —— The samples were collected from the river, at the first (Barkerville) road crossing above its confluence with the north branch.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

HOUSATONIC RIVER.

Chemical Examination of Water from the Housatonic River, at New Lenox.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29960	Jan. 16	Decided.	Slight.	.19	14.30	3.05	.0376	.0300	.0248	.0052	.34	.0120	.0018	.35	9.4
30277	Feb. 20	Slight.	Cons.	.18	7.75	2.00	.0132	.0180	.0112	.0068	.15	.0120	.0003	.30	5.1
30688	Mar. 20	Decided.	Cons.	.20	6.50	1.95	.0008	.0304	.0160	.0144	.16	.0100	.0010	.41	3.6
31027	Apr. 17	V. slight.	Cons.	.13	6.75	1.55	.0030	.0202	.0150	.0052	.15	.0110	.0002	.33	4.2
31266	May 15	V. slight.	Cons.	.12	9.05	1.65	.0082	.0232	.0170	.0062	.20	.0060	.0005	.32	5.7
31783	June 19	Decided.	Cons.	.20	10.15	2.10	.0170	.0296	.0176	.0120	.24	.0060	.0011	.34	6.0
32039	July 16	Slight.	Cons.	.14	11.30	2.55	.0384	.0208	.0164	.0044	.24	.0070	.0020	.33	6.1
32561	Aug. 20	Slight.	Cons.	.36	11.85	2.90	.0424	.0284	.0226	.0058	.22	.0100	.0052	.63	8.9
33073	Sept. 25	Slight.	Slight.	.23	14.30	2.45	.1180	.0344	.0272	.0072	.47	.0030	.0040	.40	9.3
33404	Oct. 23	V. slight.	Heavy.	.30	16.15	2.05	.1136	.0308	.0268	.0040	.48	.0100	.0040	.37	10.6
33738	Nov. 20	Decided.	Cons.	.38	12.40	3.10	.0260	.0376	.0296	.0080	.34	.0170	.0011	.69	8.1
34142	Dec. 18	Slight.	Slight.	.25	13.55	2.75	.0352	.0304	.0240	.0064	.32	.0380	.0006	.45	9.7

Averages by Years.

-	1894	-	-	.27	11.37	2.13	.0131	.0183	.0144	.0039	.25	.0204	.0024	.35	8.5
-	1895	-	-	.26	11.73	2.50	.0183	.0238	.0183	.0055	.25	.0173	.0038	.43	8.4
-	1896	-	-	.26	11.18	1.97	.0169	.0192	.0152	.0040	.22	.0208	.0036	.36	8.6
-	1897	-	-	.32	10.79	2.47	.0159	.0240	.0170	.0070	.19	.0203	.0008	.40	7.5
-	1898	-	-	.27	9.40	2.17	.0106	.0223	.0141	.0082	.15	.0178	.0008	.37	6.4
-	1899	-	-	.20	10.76	2.43	.0197	.0233	.0179	.0054	.23	.0132	.0017	.35	7.4
-	1900	-	-	.22	11.17	2.34	.0378	.0278	.0207	.0071	.28	.0118	.0018	.41	7.2

NOTE to analyses of 1900: Odor in November, decidedly disagreeable; at other times, faintly vegetable or unpleasant, sometimes becoming stronger on heating.

Chemical Examination of Water from the Housatonic River, at Stockbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
31891	June 26	V. slight.	Cons.	.11	12.05	2.25	.0284	.0312	.0236	.0076	.29	.0070	.0016	.34	9.6
32349	July 31	V. slight.	Slight.	.08	11.70	2.20	.0174	.0198	.0148	.0050	.26	.0100	.0014	.30	8.3
32743	Aug. 27	Decided.	Cons.	.15	13.60	2.75	.0208	.0240	.0200	.0040	.33	.0200	.0026	.42	9.3
33132	Sept. 26	V. slight.	Slight.	.12	13.50	2.60	.0072	.0192	.0158	.0034	.39	.0110	.0012	.27	10.3
33459	Oct. 23	V. slight.	Slight.	.15	16.65	3.25	.0228	.0236	.0186	.0050	.44	.0220	.0018	.28	11.7
33771	Nov. 21	Decided	Cons.	.35	12.35	3.00	.0204	.0380	.0300	.0080	.37	.0210	.0007	.72	8.6
Av...	....	....	....	.16	13.31	2.67	.0195	.0260	.0205	.0055	.35	.0152	.0015	.39	9.6

Odor, faintly vegetable or unpleasant, becoming stronger on heating.—The samples were collected from the river, opposite the sewage filtration area of the town of Stockbridge.

HOUSATONIC RIVER.

Chemical Examination of Water from the Housatonic River, at Sheffield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
32069	July 16	V. slight.	Slight.	.13	10.80	2.20	.0100	.0172	.0132	.0040	.19	.0110	.0008	.44	8.4
32560	Aug. 20	Slight.	Slight.	.20	11.20	2.35	.0084	.0282	.0230	.0052	.24	.0140	.0007	.38	8.6
32952	Sept. 17	V. slight.	Slight.	.14	13.55	2.30	.0064	.0236	.0190	.0046	.36	.0290	.0002	.26	9.9
33309	Oct. 15	None.	Slight.	.12	14.75	2.70	.0060	.0224	.0204	.0020	.36	.0100	.0002	.23	11.0
33740	Nov. 20	Slight.	Cons.	.23	13.75	2.00	.0092	.0248	.0184	.0064	.32	.0210	.0005	.45	9.6
34123	Dec. 17	V. slight.	Slight.	.12	12.85	2.00	.0072	.0120	.0108	.0012	.22	.0310	.0002	.28	6.7
Av...	....	....	....	.16	12.82	2.26	.0079	.0214	.0175	.0039	.28	.0193	.0004	.34	9.0

Odor of the first sample, distinctly vegetable; of the others, faintly unpleasant, becoming stronger on heating. —— The samples were collected from the river, near the lower covered bridge.

Merrimack River.

The usual monthly examinations of the water of this river above Lowell and above Lawrence have been continued during the year 1900, the detailed results of which may be found on pages 203 and 192 of this volume. A comparison of the analyses made at these two places during the year is given in the following table: —

Table comparing the Analyses above Lowell with those above Lawrence, 1900.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
Number of determinations compared, ...	12	12	12	12	12	12	12	12	12	12	12
Mean of analyses above Lowell,	.27	3.55	1.27	.0052	.0197	.0154	.0043	.193	.0049	.0002	1.1
Mean of analyses above Lawrence, ...	.30	3.96	1.38	.0089	.0224	.0180	.0044	.248	.0060	.0002	1.1
Increase, ...	.03	0.41	0.11	.0037	.0027	.0026	.0001	.055	.0011	.0000	0.0

MERRIMACK RIVER.

In order to compare these results with similar ones obtained in previous years, another table is presented, which shows the increase in impurities as the water passes from a point above Lowell to Lawrence, as given in the last line of the above table, and the corresponding increase in previous years: —

Increase in the Amount of Impurities in the Merrimack River Water, from a Point above Lowell to Lawrence, as determined by the Regular Monthly Examinations of Different Years.

[Parts per 100,000.]

Date.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.	
Increase, 1887-1889,	0.01	0.23	0.09	.0007	.0027	.0017	.0010	.026	.0003*	.0000	–
Increase, 1890,	0.05	0.62	0.22*	.0016	.0023	.0017	.0006	.028	.0020*	.0000	0.2
Increase, 1891,	0.02*	0.29	0.07	.0021	.0023	.0021	.0002	.035	.0030*	.0000	0.1
Increase, 1892,	0.06	0.48	0.12	.0019	.0037	.0037	.0000	.039	.0013*	.0000	0.0
Increase, 1893,	0.09	0.47	0.30	.0031	.0032	.0021	.0011	.035	.0002*	.0001	0.0
Increase, 1894,	0.02	0.15	0.04	.0028	.0032	.0032	.0000	.049	.0000	.0000	0.1
Increase, 1895,	0.11	0.52	0.33	.0022	.0063	.0046	.0017	.063	.0005	.0001	0.1
Increase, 1896,	0.02	0.51	0.24	.0034	.0053	.0047	.0006	.070	.0017	.0002	0.2
Increase, 1897,	0.06	0.30	0.08	.0019	.0051	.0033	.0018	.050	.0000	.0000	0.1
Increase, 1898,	0.03	0.37	0.07	.0024	.0039	.0019	.0020	.044	.0010	.0002	0.1
Increase, 1899,	0.02	0.39	0.07	.0038	.0045	.0023	.0022	.059	.0004*	.0001	0.1
Increase, 1900,	0.03	0.41	0.11	.0037	.0027	.0026	.0001	.055	.0011	.0000	0.0

The average flow of the river at Lawrence, for twenty-four hours, during the days on which samples were collected, was for the above periods, respectively, at the rate of 9,145, 9,948, 7,931, 5,434, 8,126, 5,459, 11,634, 5,886, 8,230, 9,402, 7,406 and 7,389 cubic feet per second.

* Decrease.

Chemical Examination of Water from the Merrimack River, above Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
32062	July 17	Slight.	Cons.	.23	4.65	1.00	.0192	.0288	.0192	.0096	.39	.0010	.0004	.68	1.3
32583	Aug. 21	Decided.	Cons.	.15	4.40	1.15	.0144	.0316	.0192	.0124	.39	.0050	.0008	.49	1.6
32979	Sept. 18	Slight.	Cons.	.15	5.00	1.25	.0272	.0328	.0218	.0110	.48	.0020	.0009	.41	1.3
33523	Oct. 30	Slight.	Cons.	.34	5.35	1.65	.0296	.0360	.0284	.0076	.44	.0100	.0010	.73	1.4
33743	Nov. 20	Decided.	Cons.	.65	5.30	2.10	.0144	.0328	.0288	.0040	.33	.0080	.0003	.92	1.6
Av...	....	....	....	.30	4.94	1.43	.0210	.0324	.0235	.0089	.41	.0052	.0007	.65	1.4

Odor in October, distinctly vegetable, becoming also musty on heating; at other times, faintly unpleasant, becoming stronger on heating. —— The samples were collected from the river, about a mile and a half above the Boston & Maine Railroad bridge. The samples were made up of several equal portions collected at different points across the river.

MERRIMACK RIVER.

Chemical Examination of Water from the Merrimack River, below Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
32063	July 17	Slight.	Cons.	.20	4.40	1.25	.0284	.0324	.0208	.0116	.42	.0010	.0007	.50	1.4
32584	Aug. 21	Decided.	Cons.	.15	4.50	1.15	.0220	.0276	.0192	.0084	.37	.0020	.0010	.36	1.7
32980	Sept. 18	Slight.	Cons.	.23	5.50	1.40	.0650	.0375	.0252	.0123	.57	.0040	.0017	.43	1.6
33524	Oct. 30	Decided.	Cons.	.35	5.40	1.65	.0264	.0360	.0280	.0080	.44	.0090	.0011	.68	1.1
33744	Nov. 20	Decided.	Cons.	.66	5.35	2.15	.0136	.0340	.0296	.0044	.32	.0120	.0004	.89	1.4
Av...	....	....	....	.32	5.03	1.52	.0311	.0335	.0246	.0089	.42	.0056	.0010	.57	1.2

Odor in October, distinctly vegetable; at other times, faintly unpleasant or none. —— The samples were collected from the river, at the bridge between Haverhill and Groveland. The samples were made up of four equal portions, collected at different points across the river.

Miller's River.

Chemical Examination of Water from the Miller's River, above Athol.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
32044	July 17	V. slight.	V. slight.	.61	3.60	1.50	.0072	.0264	.0240	.0024	.20	.0010	.0000	0.81	0.5
32575	Aug. 21	Decided.	Cons.	.78	5.10	2.10	.0032	.0480	.0344	.0136	.12	.0030	.0004	1.03	1.1
33005	Sept. 19	Decided.	Cons.	.70	6.45	1.75	.0020	.0775	.0268	.0507	.14	.0100	.0002	0.67	1.1
33327	Oct. 16	V. slight.	V. slight.	.87	6.45	2.40	.0048	.0300	.0284	.0016	.19	.0110	.0000	1.25	1.8
33736	Nov. 20	Slight.	V. slight.	.72	5.30	1.70	.0028	.0360	.0204	.0156	.19	.0120	.0000	1.09	1.4
34190	Dec. 20	V. slight.	Cons.	.50	3.75	1.50	.0018	.0318	.0160	.0158	.12	.0100	.0000	0.75	1.6
Av...	....	....	....	.70	5.11	1.82	.0036	.0416	.0250	.0166	.16	.0078	.0001	0.93	1.2

Odor of the last two samples, none, becoming unpleasant on heating; of the others, distinctly unpleasant and musty or vegetable. —— The samples were collected from the river, at Starrett's millpond.

MILLER'S RIVER.

Chemical Examination of Water from the Miller's River, below Orange.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Tota	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
32113	July 24	Slight.	Cons.	.59	3.50	1.40	.0064	.0292	.0232	.0060	.28	.0010	.0002	0.71	0.5
32611	Aug. 22	V. slight.	Cons.	.70	4.35	1.75	.0046	.0292	.0234	.0058	.24	.0050	.0001	0.84	0.6
33034	Sept. 21	V. slight.	Slight.	.54	4.30	2.00	.0060	.0240	.0204	.0036	.21	.0040	.0001	0.69	0.6
33429	Oct. 24	V. slight.	Cons.	.90	5.55	2.35	.0064	.0376	.0340	.0036	.26	.0030	.0002	1.19	1.1
33786	Nov. 20	V. slight.	Cons.	.95	4.50	1.95	.0056	.0284	.0232	.0052	.26	.0060	.0001	1.18	1.1
34211	Dec. 24	Decided.	Cons.	.60	4.50	1.80	.0124	.0260	.0172	.0088	.21	.0130	.0000	0.76	0.6
Av...	....	....	....	.71	4.45	1.87	.0069	.0291	.0236	.0055	.24	.0053	.0001	0.89	0.7

Odor, faintly vegetable or unpleasant, becoming stronger on heating.

Nashua River.

Chemical Examination of Water from the North Branch of the Nashua River, above Fitchburg.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
31778	June 19	V. slight.	Slight.	.38	3.35	1.40	.0002	.0170	.0154	.0016	.14	.0050	.0001	.47	0.5
32354	Aug. 1	V. slight.	V. slight.	.45	3.25	1.25	.0008	.0182	.0164	.0018	.16	.0010	.0000	.54	0.5
32730	Aug. 29	None.	V. slight.	.39	3.15	1.15	.0010	.0170	.0164	.0006	.18	.0050	.0000	.51	0.5
33108	Sept. 26	Slight.	Cons.	.38	2.65	0.95	.0008	.0216	.0156	.0060	.23	.0030	.0001	.49	0.5
33396	Oct. 23	None.	V. slight.	.42	4.25	1.50	.0012	.0192	.0172	.0020	.23	.0020	.0000	.62	0.8
33842	Nov. 28	None.	V. slight.	.60	3.50	1.75	.0022	.0178	.0164	.0014	.18	.0070	.0000	.87	1.0
34232	Dec. 26	V. slight.	V. slight.	.45	3.60	1.10	.0012	.0130	.0126	.0004	.18	.0130	.0001	.74	0.8
Av...	....	....	....	.44	3.39	1.30	.0011	.0177	.0157	.0020	.19	.0051	.0000	.61	0.7

Odor of the first sample, distinctly vegetable; of the second, faintly unpleasant; of the others, faintly vegetable or none. —— The samples were collected from the river, a short distance above the Snow millpond.

NASHUA RIVER.

Chemical Examination of Water from the North Branch of the Nashua River, below Fitchburg.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
29977	Jan. 17	Decided.	Heavy.	.50	13.05	3.85	.1480	.1058	.0515	.0543	1.26	.0070	.0015	1.11	2.5
30242	Feb. 20	Decided.	Cons.	.35	6.45	2.30	.0412	.0404	.0288	.0116	0.46	.0030	.0004	0.72	1.3
30687	Mar. 21	Decided.	Cons.	.33	3.20	1.35	.0180	.0260	.0224	.0036	0.23	.0030	.0001	0.61	0.6
31024	Apr. 17	Decided.	Cons.	.27	5.30	1.90	.0140	.0400	.0260	.0140	0.34	.0120	.0003	0.54	1.6
31286	May 16	Decided.	Cons.	.39	7.20	2.30	.0150	.0530	.0300	.0230	0.60	.0020	.0005	0.68	1.7
31779	June 19	Decided.	Heavy.	.42	7.85	2.15	.0780	.0750	.0530	.0220	0.71	.0020	.0017	0.67	2.0
32355	Aug. 1	Decided.	Cons.	.36	9.40	2.30	.1600	.0490	.0340	.0150	1.09	.0030	.0008	0.65	2.5
32731	Aug. 29	Decided.	Cons.	.50	10.90	2.35	.2000	.0805	.0218	.0587	1.50	.0040	.0022	0.76	3.5
33109	Sept. 26	Decided.	Cons.	.32	11.65	3.25	.1800	.0765	.0425	.0340	1.34	.0040	.0026	0.65	2.9
33397	Oct. 23	Decided.	Heavy.	.44	12.55	2.55	.2320	.1420	.0750	.0670	1.23	.0120	.0018	0.88	3.3
33843	Nov. 28	Decided.	Cons.	.49	4.95	1.95	.0952	.0720	.0612	.0108	0.33	.0230	.0001	0.76	1.7
34233	Dec. 26	Decided.	Cons.	.35	4.65	1.50	.0320	.0316	.0224	.0092	0.37	.0120	.0003	0.72	1.0

Averages by Years.

–	1893	–	–	.57	7.46	2.16	.0461	.0360	.0257	.0103	0.69	.0118	.0018	.69	2.0
–	1894	–	–	.56	7.39	2.00	.0634	.0346	.0251	.0095	0.75	.0152	.0020	.58	1.9
–	1895	–	–	.59	8.10	2.58	.0832	.0423	.0319	.0104	0.75	.0134	.0010	.74	2.2
–	1896	–	–	.48	8.15	2.40	.0677	.0499	.0343	.0156	0.74	.0151	.0017	.69	2.0
–	1897	–	–	.61	6.82	2.37	.0370	.0420	.0317	.0103	0.61	.0120	.0007	.68	1.8
–	1898	–	–	.51	6.00	2.09	.0435	.0467	.0308	.0159	0.48	.0117	.0009	.64	1.6
–	1899	–	–	.43	7.62	2.40	.0967	.0657	.0412	.0245	0.72	.0069	.0009	.68	1.8
–	1900	–	–	.39	8.10	2.31	.1011	.0660	.0391	.0269	0.79	.0072	.0010	.73	2.0

NOTE to analyses of 1900: Odor, generally distinctly unpleasant, sometimes also musty.——The samples were collected from the river, about half a mile below the point where water from the tail-race of the Falulah Paper Company enters the stream.

Chemical Examination of Water from Monoosnock Brook, in Leominster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
31865	June 27	Decided.	Cons.	.47	4.20	2.15	.0148	.0484	.0276	.0208	.26	.0010	.0005	.66	0.5
32342	Aug. 1	Decided.	Cons.	.60	4.60	2.15	.0356	.0460	.0304	.0156	.47	.0100	.0004	.70	0.8
32604	Aug. 22	Decided.	Cons.	.67	4.25	2.10	.0152	.0464	.0308	.0156	.25	.0030	.0004	.75	0.5
33096	Sept. 26	Decided.	Cons.	.60	4.00	1.50	.0148	.0504	.0296	.0208	.34	.0090	.0006	.74	1.1
33510	Oct. 30	Decided.	Cons.	.88	4.70	1.90	.0120	.0428	.0328	.0100	.34	.0070	.0004	.89	1.1
33814	Nov. 27	Decided.	Cons.	.53	4.20	1.20	.0048	.0284	.0220	.0064	.29	.0120	.0002	.78	1.1
Av.	....	....	....	.62	4.32	1.83	.0162	.0437	.0289	.0148	.32	.0070	.0004	.75	0.8

Odor, generally distinctly unpleasant ——The samples were collected from the brook, a short distance below the village of Leominster.

NASHUA RIVER.

Chemical Examination of Water from the North Branch of the Nashua River, just above its Confluence with the South Branch at Lancaster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
29946	Jan. 15	Decided.	Cons.	.40	9.80	2.60	.1536	.0456	.0368	.0088	1.08	.0070	.0012	.69	2.6
30267	Feb. 21	Decided.	Cons.	.28	5.00	1.55	.0268	.0288	.0212	.0076	0.40	.0070	.0003	.49	1.7
30682	Mar. 21	Decided.	Cons.	.33	2.75	1.30	.0072	.0232	.0192	.0040	0.15	.0020	.0000	.52	0.5
31041	Apr. 18	Slight.	Cons.	.32	4.25	1.45	.0146	.0242	.0186	.0056	0.32	.0030	.0004	.50	1.1
31282	May 16	Slight.	Cons.	.30	5.15	1.40	.0340	.0365	.0240	.0125	0.53	.0050	.0006	.50	1.7
31845	June 25	V. slight.	Slight.	.24	6.10	1.35	.0530	.0318	.0242	.0076	0.62	.0110	.0020	.45	1.7
32056	July 17	V. slight.	Slight.	.14	6.40	1.15	.0540	.0310	.0215	.0095	0.74	.0100	.0044	.48	2.0
32573	Aug. 21	V. slight.	Cons.	.19	7.70	1.55	.0549	.0329	.0260	.0069	0.95	.0150	.0068	.47	2.1
32971	Sept. 18	V. slight.	Slight.	.27	9.00	2.00	.0412	.0304	.0270	.0034	1.06	.0300	.0070	.49	2.5
33318	Oct. 16	Slight.	Cons.	.37	7.50	1.65	.0688	.0376	.0320	.0056	0.84	.0320	.0026	.53	2.1
33734	Nov. 20	Decided.	Cons.	.53	6.35	1.60	.0552	.0320	.0276	.0044	0.64	.0230	.0006	.69	2.0
34134	Dec. 18	Decided.	Slight.	.40	6.10	1.80	.0380	.0330	.0285	.0045	0.62	.0380	.0009	.69	1.8

Averages by Years.

-	1895	-	-	.51	6.96	2.10	.0282	.0269	.0208	.0061	0.77	.0236	.0019	.59	1.9
-	1896	-	-	.47	6.16	1.95	.0217	.0293	.0224	.0069	0.55	.0155	.0019	.55	1.8
-	1897	-	-	.54	5.29	1.99	.0285	.0290	.0230	.0060	0.42	.0150	.0008	.59	1.5
-	1898	-	-	.45	5.07	1.74	.0222	.0268	.0200	.0068	0.44	.0168	.0013	.46	1.5
-	1899	-	-	.36	6.38	2.01	.0540	.0316	.0254	.0062	0.60	.0132	.0016	.53	1.6
-	1900	-	-	.31	6.34	1.62	.0501	.0322	.0255	.0067	0.66	.0152	.0022	.54	1.8

NOTE to analyses of 1900: Odor, generally faintly unpleasant, becoming stronger on heating. —— The samples were collected from the river, near the railroad bridge, a short distance above its mouth.

NASHUA RIVER.

Chemical Examination of Water from the South Branch of the Nashua River, just above its Confluence with the North Branch at Lancaster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1900.														
29947	Jan. 15	Decided.	Cons.	.36	9.65	2.55	.1360	.0460	.0340	.0120	1.14	.0050	.0010	.57	2.6
30266	Feb. 21	Decided.	Slight.	.35	5.25	1.50	.0684	.0268	.0220	.0048	0.54	.0060	.0003	.55	1.4
30683	Mar. 21	Decided.	Cons.	.36	2.45	1.15	.0032	.0184	.0152	.0032	0.14	.0010	.0001	.50	0.5
31042	Apr. 18	Slight.	Cons.	.30	4.30	1.35	.0342	.0212	.0168	.0044	0.30	.0060	.0004	.48	1.1
31283	May 16	Slight.	Slight.	.36	3.40	1.25	.0018	.0202	.0166	.0036	0.31	.0010	.0002	.57	1.1
31846	June 25	Slight.	Cons.	.33	8.40	2.00	.0784	.0394	.0272	.0122	1.24	.0200	.0015	.49	2.2
32057	July 17	Slight.	Cons.	.31	9.20	1.45	.0460	.0430	.0275	.0155	1.24	.0070	.0022	.50	2.2
32574	Aug. 21	Decided.	Cons.	.34	11.25	2.15	.0708	.0368	.0244	.0124	1.50	.0650	.0080	.44	2.3
32972	Sept. 18	Decided.	Cons.	.34	11.60	2.65	.0504	.0408	.0284	.0124	1.72	.1400	.0050	.46	2.3
33319	Oct. 16	Decided.	Cons.	.43	11.35	2.60	.0592	.0416	.0336	.0080	1.72	.0650	.0024	.46	2.6
33735	Nov. 20	Decided.	Cons.	.34	9.40	2.05	.0456	.0336	.0272	.0064	1.28	.0610	.0017	.49	2.3
34135	Dec. 18	Decided.	Slight.	.20	6.50	1.80	.0510	.0470	.0200	.0270	0.84	.0940	.0012	.41	2.0

Averages by Years.

-	1895	-	-	.53	4.66	1.77	.0167	.0238	.0185	.0053	0.34	.0114	.0008	.61	1.4
-	1896	-	-	.45	4.72	1.69	.0094	.0216	.0180	.0036	0.35	.0134	.0006	.53	1.6
-	1897	-	-	.60	4.47	1.80	.0092	.0257	.0202	.0055	0.32	.0110	.0004	.56	1.3
-	1898	-	-	.50	4.77	1.81	.0327	.0269	.0206	.0063	0.33	.0098	.0010	.48	1.3
-	1899	-	-	.45	7.34	2.12	.1026	.0415	.0310	.0105	0.75	.0087	.0018	.54	1.7
-	1900	-	-	.33	7.73	1.87	.0537	.0346	.0244	.0102	1.00	.0392	.0020	.49	1.9

NOTE to analyses of 1900: Odor, generally distinctly unpleasant.——The samples were collected from the river, at the Atherton bridge, a short distance above its mouth, and a short distance below the point where the brook from the Clinton sewage filtration area enters the stream.

NASHUA RIVER.

Chemical Examination of Water from the Nashua River, at Pepperell.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
32038	July 16	V. slight.	V. slight.	.15	6.00	1.70	.0100	.0200	.0192	.0008	.70	.0050	.0005	.36	2.0
32572	Aug. 21	Slight.	V. slight.	.23	6.50	1.75	.0234	.0258	.0228	.0030	.92	.0100	.0018	.45	2.0

Odor, faintly vegetable, becoming faintly unpleasant and fishy in the first, and distinctly vegetable in the last sample, on heating.

Nemasket River.

Chemical Examination of Water from the Nemasket River, below Middleborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
32047	July 17	V. slight.	Slight.	.30	3.30	1.25	.0072	.0196	.0184	.0012	.58	.0020	.0002	.55	0.6
32567	Aug. 21	V. slight.	V. slight.	.34	4.10	1.20	.0038	.0256	.0234	.0022	.64	.0040	.0000	.54	0.6
32978	Sept. 18	Slight.	Slight.	.31	4.85	1.30	.0152	.0254	.0214	.0040	.86	.0040	.0004	.47	1.0
33323	Oct. 16	None.	Slight.	.50	5.10	1.60	.0144	.0240	.0222	.0018	.68	.0040	.0002	.74	1.1
33725	Nov. 20	Slight.	Slight.	.33	4.20	1.60	.0164	.0248	.0208	.0040	.63	.0050	.0002	.54	0.8
34252	Dec. 28	V. slight.	Slight.	.29	3.95	1.70	.0076	.0188	.0154	.0034	.61	.0070	.0001	.52	0.5
Av...	....	....	....	.34	4.25	1.44	.0108	.0230	.0202	.0028	.67	.0043	.0002	.56	0.8

Odor of the last sample, distinctly unpleasant and musty; of the others, faintly vegetable, becoming stronger on heating. —— The samples were collected from the river, at Muttock dam.

Neponset River.

Chemical Examination of Water from the Neponset River, at Hyde Park.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29953	Jan. 16	Decided.	Cons.	0.70	7.05	2.80	.0044	.0272	.0164	.0108	0.63	.0070	.0004	1.00	2.2
30238	Feb. 20	Decided.	Cons.	0.90	6.25	2.60	.0012	.0316	.0272	.0044	0.60	.0050	.0002	1.17	2.2
30716	Mar. 22	V. slight.	Slight.	0.59	4.40	1.85	.0004	.0222	.0196	.0026	0.50	.0010	.0000	0.84	1.6
31021	Apr. 17	Decided.	Cons.	0.70	6.30	2.65	.0006	.0314	.0254	.0060	0.58	.0050	.0000	0.91	1.8
31258	May 15	Slight.	Cons.	1.20	6.25	2.85	.0070	.0392	.0312	.0080	0.63	.0050	.0004	1.10	2.1
31781	Jnne 19	Slight.	Slight.	1.20	8.35	2.45	.0615	.0390	.0365	.0025	0.97	.0010	.0003	1.00	2.6
32311	Jnly 31	Decided.	Cons.	1.00	12.15	3.10	.0336	.0832	.0492	.0340	2.37	.0000	.0001	1.29	3.8
32705	Aug. 29	Decided.	Cons.	1.25	10.85	3.05	.0600	.0740	.0585	.0155	1.24	.0040	.0004	0.93	3.6
33044	Sept. 24	Decided.	Cons.	0.98	12.75	3.00	.0304	.0480	.0452	.0028	1.67	.0030	.0004	0.77	4.3
33499	Oct. 30	Decided.	Cons.	1.05	9.80	3.20	.0368	.0476	.0222	.0254	1.23	.0070	.0008	1.22	2.6
33822	Nov. 27	Decided.	Cons.	1.10	9.65	3.15	.0175	.0540	.0172	.0368	1.25	.0140	.0009	1.24	2.6
34215	Dec. 24	Decided.	Cons.	1.10	12.65	3.30	.0220	.0800	.0575	.0225	1.87	.0180	.0014	1.76	5.0

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1888	-	-	1.02	6.77	2.27	.0030	.0324	-	-	0.83	.0095	.0002	-	-
-	1893	-	-	1.16	7.70	2.49	.0151	.0320	.0254	.0066	1.19	.0154	.0005	0.95	2.4
-	1894	-	-	1.14	9.68	2.69	.0112	.0360	.0277	.0083	1.64	.0062	.0002	1.00	3.0
-	1895	-	-	1.04	8.40	2.81	.0182	.0365	.0312	.0053	1.18	.0064	.0001	1.05	3.0
-	1896	-	-	1.12	8.35	2.69	.0137	.0353	.0315	.0038	1.22	.0077	.0001	1.06	2.7
-	1897	-	-	1.19	8.79	2.84	.0193	.0385	.0333	.0052	1.28	.0067	.0001	1.07	2.9
-	1898	-	-	1.11	7.29	2.89	.0097	.0387	.0315	.0072	0.88	.0060	.0002	1.06	2.4
-	1899	-	-	0.90	10.91	3.36	.0159	.0597	.0463	.0134	1.39	.0052	.0002	1.28	3.6
-	1900	-	-	0.98	8.87	2.83	.0229	.0481	.0338	.0143	1.13	.0058	.0004	1.10	2.9

NOTE to analyses of 1900: Odor, distinctly unpleasant or disagreeable, sometimes musty. —— The samples were collected from the river, opposite the works of the Hyde Park Water Company, above the thickly settled portions of the town of Hyde Park.

Quaboag River.

(See *Chicopee River.*)

QUINEBAUG RIVER.

Quinebaug River.

Chemical Examination of Water from the Quinebaug River, below Southbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
31567	June 12	Slight.	Cons.	.37	3.85	1.35	.0048	.0262	.0212	.0050	.22	.0050	.0003	.53	0.6
32424	Aug. 6	Slight.	Cons.	.50	4.15	1.50	.0096	.0236	.0200	.0036	.19	.0010	.0002	.55	0.8
32562	Aug. 18	Slight.	Cons.	.55	4.25	1.80	.0112	.0308	.0260	.0048	.23	.0020	.0001	.64	1.0
32953	Sept. 17	Decided.	Cons.	.38	4.65	1.50	.0155	.0415	.0274	.0141	.37	.0020	.0005	.51	1.1
33642	Nov. 10	Decided.	Cons.	.32	4.55	1.75	.0364	.0348	.0130	.0218	.21	.0010	.0004	.46	1.6
Av.*.	....	....	....	.40	4.31	1.56	.0168	.0324	.0211	.0113	.25	.0024	.0003	.52	1.0

Odor of the first and fourth samples, faintly musty; of the second, none, becoming oily on heating; of the third, faintly vegetable, becoming stronger on heating; of the last, faintly earthy. —— The samples were collected from the river, between the villages of Southbridge and Saundersdale.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Salisbury Plain River.

Chemical Examination of Water from Salisbury Plain River, below Brockton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
32046	July 17	Decided.	Cons.	.30	11.80	2.55	.0144	.0284	.0184	.0100	1.83	.1160	.0400	0.41	3.9
32568	Aug. 21	Slight.	Slight.	.13	13.80	3.80	.0154	.0200	.0194	.0006	2.14	.3100	.0012	0.29	3.9
32960	Sept. 18	Decided.	Heavy.	–	9.25	2.25	.0615	.0505	.0300	.0205	1.25	.0820	.0016	1.09	2.3
33313	Oct. 16	V. slight.	Cons.	.49	10.30	2.60	.0928	.0284	.0260	.0024	1.56	.1160	.0060	0.56	3.1
33724	Nov. 20	Decided.	Cons.	.70	12.45	3.15	.2500	.0460	.0265	.0195	1.83	.2400	.0032	0.50	2.9
34130	Dec. 18	Slight.	Slight.	.33	10.65	3.05	.1840	.0164	.0152	.0012	1.50	.2650	.0010	0.41	3.0
Av...	....	....	....	.39	11.37	2.90	.1030	.0316	.0226	.0090	1.68	.1882	.0088	0.54	3.2

Odor, generally distinctly unpleasant, sometimes musty. —— The samples were collected from the river, at Plain Street bridge, above the sewage pumping station.

Shawsheen River.

Chemical Examination of Water from the Shawsheen River, below Andover.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
32059	July 17	Decided.	Cons.	.45	4.85	1.50	.0030	.0385	.0250	.0135	.38	.0020	.0000	0.65	1.1
32549	Aug. 20	Decided.	Slight.	.48	5.00	1.60	.0052	.0272	.0224	.0048	.38	.0060	.0001	0.69	1.1
33038	Sept. 24	Slight.	Cons.	.60	6.85	4.45	.0140	.0416	.0336	.0080	.50	.0060	.0001	1.09	1.7
Av...	....	....	....	.51	5.57	2.52	.0074	.0358	.0270	.0088	.42	.0047	.0001	0.81	1.3

Odor, generally unpleasant, becoming stronger on heating.

Swift River.

(See *Chicopee River.*)

Taunton River.

Chemical Examination of Water from the Taunton River, at State Farm, Bridgewater.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
32338	July 31	V. slight.	Slight.	0.68	5.30	1.90	.0008	.0232	.0208	.0024	.74	.0050	.0001	0.70	0.8
32477	Aug. 13	Slight.	Slight.	0.66	4.85	1.50	.0072	.0268	.0240	.0028	.74	.0100	.0001	0.67	0.8
33295	Oct. 12	V. slight.	Slight.	0.58	5.85	1.95	.0068	.0288	.0212	.0076	.89	.0150	.0001	0.73	1.4
33460	Oct. 25	V. slight.	Slight.	0.60	6.35	2.00	.0044	.0276	.0256	.0020	.87	.0280	.0005	0.75	1.6
33606	Nov. 6	None.	V. slight.	0.85	7.30	2.70	.0036	.0284	.0244	.0040	.78	.0100	.0002	1.41	1.4
33737	Nov. 20	Slight.	V. slight.	0.80	6.50	2.55	.0048	.0300	.0260	.0040	.78	.0190	.0003	1.08	1.3
33942	Dec. 4	V. slight.	V. slight.	1.24	7.10	3.50	.0054	.0304	.0290	.0014	.64	.0150	.0001	1.72	1.7
34131	Dec. 18	V. slight.	V. slight.	1.04	7.00	2.75	.0116	.0312	.0266	.0046	.75	.0400	.0000	1.36	1.4
Av.*.	....	....	....	0.78	6.04	2.22	.0053	.0276	.0242	.0034	.77	.0147	.0001	0.98	1.2

Odor, generally unpleasant, sometimes vegetable. —— The first sample was collected from a faucet at the asylum; the others, from the river near the pumping station.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

TAUNTON RIVER.

Chemical Examination of Water from the Taunton River, above Taunton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
32086	July 19	V. slight.	V. slight.	.78	4.30	1.90	.0052	.0248	.0236	.0012	.56	.0030	.0001	.78	0.6
33013	Sept. 20	V. slight.	Cons.	.35	5.15	1.65	.0028	.0208	.0186	.0022	.70	.0020	.0001	.48	1.0
33407	Oct. 23	None.	Cons.	.70	7.40	2.00	.0064	.0276	.0260	.0016	.84	.0130	.0002	.87	1.6
33790	Nov. 23	Slight.	Cons.	.80	6.85	2.50	.0136	.0260	.0236	.0024	.80	.0220	.0004	.90	1.4
Av...	....	....	....	.66	5.92	2.01	.0070	.0248	.0229	.0019	.72	.0100	.0002	.76	1.1

Odor of the last sample, distinctly unpleasant; of the others, faintly vegetable, becoming stronger on heating. —— The samples were collected from the river, opposite the pumping station of the Taunton Water Works.

Chemical Examination of Water from the Taunton River, below Taunton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
32087	July 19	V. slight.	Slight.	.85	5.15	2.00	.0152	.0276	.0264	.0012	0.68	.0020	.0007	.84	1.0
33014	Sept. 20	Slight.	Cons.	.46	5.65	1.60	.0240	.0242	.0220	.0022	0.90	.0110	.0005	.53	1.1
33406	Oct. 23	V. slight.	Cons.	.72	8.40	1.70	.0276	.0352	.0296	.0056	1.10	.0110	.0009	.80	1.8
33791	Nov. 23	Decided.	Cons.	.80	8.35	2.35	.0152	.0276	.0252	.0024	1.57	.0210	.0005	.89	2.0
Av...	....	....	....	.71	6.89	1.91	.0205	.0286	.0258	.0028	1.06	.0112	.0006	.76	1.5

Odor in September, faintly vegetable, becoming stronger on heating; at other times, faintly unpleasant, becoming stronger in the last two samples on heating. —— The samples were collected from the river, at the wharf of the Taunton Gas Works, below the bridge at Weir.

Ten Mile River.

Chemical Examination of Water from Ten Mile River, below Attleborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
31560	June 12	Decided.	Cons.	1.00	5.85	2.50	.0136	.0544	.0344	.0200	0.54	.0110	.0008	.90	1.3
32007	July 11	Decided.	Cons.	0.79	5.50	1.70	.0136	.0372	.0292	.0080	0.70	.0110	.0005	.68	2.0
32525	Aug. 15	Slight.	Cons.	0.32	5.25	1.30	.0072	.0276	.0224	.0052	0.80	.0110	.0002	.39	1.3
32894	Sept. 12	Decided.	Cons.	0.22	6.40	1.35	.0040	.0415	.0214	.0201	1.10	.0110	.0004	.33	1.7
33271	Oct. 10	Slight	Slight.	0.30	6.35	1.20	.0056	.0306	.0178	.0128	0.90	.0280	.0004	.26	1.8
33656	Nov. 13	Decided.	Slight.	0.21	7.80	1.55	.0310	.0266	.0192	.0074	1.03	.0210	.0004	.40	2.7
34081	Dec. 13	V. slight.	Slight.	0.85	7.15	2.55	.0262	.0296	.0244	.0052	0.67	.0360	.0012	.89	2.2
Av...	....	....	....	0.53	6.33	1.74	.0145	.0354	.0241	.0113	0.82	.0184	.0006	.55	1.9

Odor, faintly vegetable or unpleasant, becoming stronger on heating.—The samples were collected from the river, below Dodgeville.

Ware River.

(See *Chicopee River.*)

Westfield River.

Chemical Examination of Water from the Middle Branch of the Westfield River, at Huntington.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1900.														
29853	Jan. 3	None.	V. slight.	.03	3.20	0.70	.0000	.0040	.0040	.0000	.10	.0130	.0000	.16	1.7
30101	Feb. 2	None.	None.	.08	3.25	1.05	.0000	.0040	.0040	.0000	.10	.0010	.0001	.19	1.1
30375	Mar. 5	V. slight.	V. slight.	.13	2.30	0.80	.0000	.0050	.0046	.0004	.04	.0010	.0001	.26	0.6
30963	Apr. 10	V. slight.	V. slight.	.10	2.40	0.85	.0004	.0096	.0092	.0004	.07	.0020	.0000	.25	0.8
31106	Apr. 27	V. slight.	V. slight.	.10	2.85	0.85	.0004	.0078	.0072	.0006	.09	.0010	.0000	.25	1.1
32152	July 25	None.	V. slight	.05	3.20	0.90	.0004	.0078	.0072	.0006	.07	.0000	.0001	.19	1.7
32774	Sept. 3	None.	V. slight	.01	3.65	0.90	.0008	.0056	.0054	.0002	.08	.0040	.0000	.09	1.7
32996	Sept. 19	None.	V. slight.	.03	3.90	0.85	.0000	.0040	.0038	.0002	.10	.0030	.0000	.04	2.0
33176	Oct. 3	None.	None.	.03	3.65	0.70	.0000	.0054	.0054	.0000	.10	.0020	.0000	.08	2.0
33330	Oct. 17	None.	None.	.06	3.40	0.75	.0006	.0058	.0058	.0000	.12	.0010	.0000	.14	2.2
33604	Nov. 7	None.	None.	.02	3.90	1.00	.0004	.0040	.0040	.0000	.13	.0030	.0000	.11	1.8
33765	Nov. 21	None.	V. slight.	.25	3.70	1.20	.0014	.0136	.0126	.0010	.14	.0100	.0000	.50	1.6
33953	Dec. 5	None.	V. slight.	.34	3.15	1.35	.0018	.0110	.0106	.0004	.11	.0100	.0000	.52	1.4
34182	Dec. 19	None.	None.	.04	3.25	1.05	.0002	.0042	.0040	.0002	.11	.0110	.0001	.13	1.7
Av.*	....	....	....	.09	3.21	0.91	.0004	.0063	.0060	.0003	.09	.0043	.0000	.20	1.5

Odor, generally none. A faintly vegetable odor was developed in several of the samples on heating.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

WESTFIELD RIVER.

Chemical Examination of Water from the East Branch of the Westfield River, at Huntington.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1900.														
29852	Jan. 3	None.	V. slight.	.07	3.65	0.95	.0000	.0048	.0048	.0000	.12	.0230	.0000	.21	1.6
30100	Feb. 2	None.	None.	.12	3.35	1.20	.0002	.0064	.0064	.0000	.10	.0020	.0001	.24	1.3
30376	Mar. 5	V. slight.	V. slight.	.20	2.25	0.75	.0000	.0066	.0062	.0004	.05	.0010	.0000	.30	0.5
30962	Apr. 10	V. slight.	V. slight.	.15	2.50	0.90	.0002	.0082	.0082	.0000	.05	.0030	.0001	.31	0.8
31105	Apr. 27	V. slight.	Slight.	.18	2.60	0.85	.0002	.0082	.0076	.0006	.09	.0020	.0000	.35	1.1
32151	July 25	V. slight.	V. slight.	.13	3.50	1.00	.0010	.0136	.0128	.0008	.08	.0000	.0000	.36	1.6
32775	Sept. 3	V. slight.	V. slight.	.07	3.80	0.85	.0010	.0090	.0086	.0004	.09	.0040	.0000	.19	1.7
32995	Sept. 19	None.	V. slight.	.06	3.45	0.85	.0000	.0084	.0080	.0004	.10	.0020	.0000	.16	1.8
33175	Oct. 3	None.	V. slight.	.06	3.55	0.85	.0002	.0070	.0062	.0008	.10	.0030	.0000	.12	1.8
33329	Oct. 17	None.	None.	.27	4.00	1.10	.0012	.0124	.0118	.0006	.15	.0010	.0000	.34	2.1
33603	Nov. 7	None.	None.	.10	3.85	1.00	.0002	.0100	.0090	.0010	.14	.0020	.0000	.21	1.7
33764	Nov. 21	V. slight.	V. slight.	.23	3.85	1.25	.0010	.0118	.0114	.0004	.13	.0070	.0000	.41	2.0
33952	Dec. 5	V. slight.	V. slight.	.32	2.90	1.25	.0018	.0122	.0116	.0006	.10	.0090	.0000	.57	1.0
34181	Dec. 19	None.	None.	.11	3.80	1.35	.0006	.0076	.0068	.0008	.11	.0110	.0001	.31	1.7
Av.*.	....	....	....	.14	3.32	1.00	.0005	.0087	.0083	.0004	.10	.0053	.0000	.29	1.4

Odor, generally none. A faintly vegetable odor was developed in several of the samples on heating.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Chemical Examination of Water from the Westfield River, above Westfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1900.														
32097	July 20	V. slight.	V. slight.	.09	4.35	1.20	.0018	.0124	.0112	.0012	.13	.0010	.0000	0.11	2.5
32571	Aug. 21	V. slight.	Slight.	.30	5.10	1.45	.0020	.0170	.0158	.0012	.12	.0030	.0001	0.63	2.2
32933	Sept. 14	V. slight.	V. slight.	.10	4.30	0.90	.0010	.0100	.0092	.0008	.16	.0020	.0000	0.17	2.3
33346	Oct. 18	None.	V. slight.	.10	4.25	0.90	.0000	.0090	.0086	.0004	.17	.0030	.0000	0.20	2.3
33627	Nov. 12	Slight.	V. slight.	.57	5.35	2.45	.0010	.0216	.0212	.0004	.20	.0160	.0001	1.08	2.1
33995	Dec. 10	None.	Slight.	.22	3.55	1.25	.0006	.0100	.0092	.0008	.12	.0080	.0001	0.40	2.0
Av...	....	....	....	.23	4.48	1.36	.0011	.0133	.0125	.0008	.15	.0055	.0000	0.43	2.2

Odor of the second and last samples, faintly vegetable; of the others, none.—— The samples were collected from the river, above the thickly settled portions of the town.

WESTFIELD RIVER.

Chemical Examination of Water from the Westfield River, below Westfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
32336	July 23	V. slight.	Cons.	.04	5.05	1.00	.0624	.0240	.0164	.0076	.33	.0060	.0011	.24	2.5
32570	Aug. 21	Slight.	Cons.	.32	4.70	1.50	.0108	.0266	.0194	.0072	.16	.0050	.0003	.64	1.8
32968	Sept. 18	Decided.	Slight.	.17	5.90	1.50	.0128	.0520	.0440	.0080	.32	.0090	.0011	.36	2.3
33315	Oct. 16	Slight.	Cons.	.11	4.70	1.00	.0090	.0192	.0150	.0042	.24	.0050	.0008	.20	2.6
33646	Nov. 13	Slight.	Slight.	.55	5.50	2.05	.0058	.0280	.0252	.0028	.26	.0180	.0002	.30	2.2
33992	Dec. 10	V. slight.	V. slight.	.22	4.20	1.60	.0028	.0128	.0118	.0010	.15	.0090	.0001	.41	2.1
Av...	....	....	....	.23	5.01	1.44	.0173	.0271	.0220	.0051	.24	.0087	.0006	.44	2.2

Odor in September, none; in October, distinctly vegetable, becoming distinctly musty on heating; at other times, faintly unpleasant, generally becoming stronger on heating. —— The samples were collected from the river, at Mittineague.

SUMMARY

OF

WATER SUPPLY STATISTICS;

ALSO

RECORDS OF RAINFALL AND FLOW OF STREAMS.

SUMMARY OF WATER SUPPLY STATISTICS.

During the year 1900 public water supplies were introduced into the towns of Dracut and Northfield. At the end of the year the State contained 32 cities and 321 towns, and all of the cities and 134 of the towns were provided with public water supplies. The following table gives a classification by population of cities and towns having and not having public water supplies, Dec. 31, 1900. The populations are taken from the census of 1900.

Population (1900).	Number of Places of Given Population having a Public Water Supply.	Total Population of Places in Preceding Column.	Number of Places of Given Population not having a Public Water Supply.	Total Population of Places in Preceding Column.
Under 500,	0	0	37	13,383
500-999,	2	1,650	51	39,792
1,000-1,499,	11	13,994	36	43,435
1,500-1,999,	9	15,893	33	56,669
2,000-2,499,	10	21,959	14	31,473
2,500-2,999,	7	18,755	6	16,598
3,000-3,499,	10	32,018	3	10,020
3,500-3,999,	9	33,123	5	18,590
4,000-4,499,	7	29,878	1	4,364
4,500-4,999,	9	42,170	0	0
Above 5,000,	92	2,355,861	1	5,721
Totals,	166	2,565,301	187	240,045

From the totals given in the preceding table it will be seen that 47 per cent. of the total number of cities and towns are provided with public water supplies, and that 91.4 per cent. of the total population of the State is contained within these cities and towns. The number of people to whom a public water supply is available is of course somewhat less than the total population of the cities and towns supplied, but the difference is not large.

There are now 10 towns having, by the census of 1900, a population exceeding 3,000 which are not provided with public water supplies. These are given in the following table: —

Town.	Population in 1900.	Town.	Population in 1900.
Blackstone,	5,721	Dartmouth,	3,669
Barnstable,	4,364	Dudley,	3,553
Chelmsford,	3,984	Templeton,	3,489
Pepperell,	3,701	Sutton,	3,328
Tewksbury,	3,683	Hardwick,	3,203

In the following table the various water supplies are classified according to the dates when a fairly complete system was introduced into a city or town: —

Year.	Number of Places supplied.	Year.	Number of Places supplied.
Previous to 1850,	6	1880-1889,	68
1850-1859,	4	1890-1899,	32
1860-1869,	10	1900,	2
1870-1879,	44	Total,	166

Of the 166 cities and towns having public water supplies, all of the cities and 83 of the towns, having an aggregate population of 2,328,432, own their works, while 50 towns, having a population of 236,869, are supplied by private companies.

Statistics in regard to the consumption of water, in the cities and towns in the State where such records are kept, for the year 1900 and for previous years, are given in a subsequent portion of this report.

RAINFALL.

The average rainfall in Massachusetts, as deduced from long-continued observations in various parts of the State, is 45.36 inches. The average rainfall for the year 1900 in these places was 46.90 inches, making an excess for the year 1900 of 1.54 inches. There was a large excess in the months of February, March, May and November, and a slight excess in January and September. The greatest deficiency occurred in the months of April, July and August. The effect of the large deficiency in the summer months was to make the flow of the streams very low, especially of those streams on which there are few ponds or storage reservoirs to maintain the flow. The following table gives the normal rainfall for each month, as deduced from observations for a long period of years, together with the rainfall for each month in 1900 and the departures from the normal: —

MONTH.	Normal Rainfall. Inches.	Rainfall. 1900. Inches.	Excess or Deficiency. 1900. Inches.	MONTH.	Normal Rainfall. Inches.	Rainfall. 1900. Inches.	Excess or Deficiency. 1900. Inches.
January, . .	3.98	4.43	+0.45	August, . .	4.29	2.31	−1.98
February, . .	3.80	7.64	+3.84	September, .	3.35	3.71	+0.36
March, . .	4.04	5.03	+0.99	October, . .	4.07	4.00	−0.07
April, . . .	3.35	1.95	−1.40	November, .	4.21	5.23	+1.02
May, . . .	3.72	4.88	+1.16	December, . .	3.52	2.63	−0.89
June, . . .	3.21	2.41	−0.80	Total, . .	45.36	46.90	+1.54
July, . . .	3.82	2.68	−1.14				

To show the condition of the streams or sources of water supply from which samples of water have been collected for analysis during 1900, the following tables are presented, which give the daily rainfall in inches at 10 stations scattered throughout the State: —

Daily Rainfall in Inches at Ten Places in Massachusetts, Geographically selected.

January, 1900.											February, 1900.										
Day of Month.	Pittsfield.	Springfield.	Amherst.	Fitchburg.	Worcester.	Lawrence.	Chestnut Hill.	Brockton.	New Bedford.	Barnstable.	Day of Month.	Pittsfield.	Springfield.	Amherst.	Fitchburg.	Worcester.	Lawrence.	Chestnut Hill.	Brockton.	New Bedford.	Barnstable.
1, .	–	0.60	0.50	0.36	0.13	0.77	0.45	0.38	0.42	0.43	1, .	–	–	–	–	–	–	–	–	–	–
2, .	0.27	–	–	–	–	–	–	–	–	–	2, .	–	–	–	–	–	–	–	–	–	–
3, .	–	–	–	–	–	–	–	–	–	–	3, .	–	–	–	–	–	–	–	–	–	–
4, .	–	–	–	–	–	–	–	–	–	–	4, .	–	*	–	0.07	*	–	–	*	–	0.36
5, .	–	–	–	–	–	–	–	–	–	–	5, .	1.20	1.92	2.07	1.12	0.92	1.05	0.86	1.05	0.63	0.16
6, .	–	–	–	–	–	–	–	–	–	0.01	6, .	–	–	–	0.01	–	–	–	–	–	–
7, .	–	0.02	–	–	0.20	–	0.11	0.05	–	–	7, .	–	–	–	–	–	–	–	–	–	–
8, .	0.12	–	0.05	0.06	–	0.04	–	–	–	0.07	8, .	0.50	*	0.51	0.37	*	–	–	*	*	0.19
9, .	–	–	–	–	–	–	–	–	–	–	9, .	0.35	1.07	0.36	0.60	0.77	0.94	0.76	0.60	0.78	0.35
10, .	0.06	0.02	0.04	–	0.07	–	–	–	–	–	10, .	–	–	–	–	–	–	–	–	–	–
11, .	0.65	*	–	–	*	*	*	*	–	0.40	11, .	–	–	–	–	–	–	*	–	–	0.5
12, .	–	1.23	1.18	1.17	1.26	1.13	1.45	1.47	–	1.26	12, .	–	*	0.15	0.09	*	–	2.08	*	–	–
13, .	–	–	–	–	–	–	–	–	2.17	0.14	13, .	2.68	3.18	3.16	3.12	3.16	2.46	–	1.57	0.81	0.62
14, .	–	0.08	0.09	0.08	0.12	0.07	0.14	0.10	*	0.07	14, .	–	–	–	–	–	–	–	–	–	–
15, .	0.40	–	–	0.03	–	–	–	–	0.15	0.04	15, .	–	–	–	–	–	–	–	–	–	–
16, .	0.12	0.08	0.13	0.21	0.15	0.28	0.13	0.10	0.02	–	16, .	–	–	–	–	–	–	–	–	–	–
17, .	–	–	–	–	–	–	–	–	–	–	17, .	–	*	0.10	0.05	*	–	*	*	*	*
18, .	–	*	*	–	–	–	0.02	–	–	–	18, .	0.25	1.00	0.26	0.91	0.52	0.35	1.20	0.47	0.70	0.85
19, .	0.09	0.02	0.07	0.05	–	0.14	–	–	–	–	19, .	–	–	–	–	–	–	–	–	–	–
20, .	0.14	*	0.63	0.58	0.60	*	0.67	0.60	–	0.85	20, .	–	–	–	–	–	–	–	–	–	–
21, .	0.93	0.72	0.72	0.49	–	0.57	–	–	1.09	0.08	21, .	–	–	–	–	–	–	–	–	–	–
22, .	–	–	–	–	–	–	–	–	–	–	22, .	1.05	*	*	1.42	0.90	–	*	1.74	1.22	1.57
23, .	–	–	–	–	–	–	–	–	–	–	23, .	0.15	0.41	0.65	0.08	–	2.03	2.14	–	–	0.01
24, .	–	–	–	–	–	–	–	–	–	–	24, .	–	–	–	–	*	–	–	*	–	–
25, .	–	–	0.13	0.40	0.38	*	*	0.47	*	0.10	25, .	0.62	1.11	1.30	1.12	1.18	1.34	1.70	1.00	0.48	0.58
26, .	0.18	0.21	–	–	–	0.70	0.57	–	0.31	0.25	26, .	–	–	–	–	–	–	–	–	–	–
27, .	–	–	–	–	–	–	–	–	–	–	27, .	–	–	–	–	–	–	–	–	–	–
28, .	–	*	0.15	–	0.20	*	*	*	*	–	28, .	–	–	–	–	–	–	–	–	–	–
29, .	0.93	0.62	0.79	1.06	–	1.40	0.84	0.90	1.04	1.83											
30, .	–	–	–	–	–	–	–	–	–	–											
31, .	–	–	–	–	0.02	–	–	0.04	0.04	0.02											
Tot.,	3.89	3.60	4.48	4.49	3.13	5.10	4.38	4.11	5.24	5.55	Tot.,	6.80	8.69	8.56	8.96	7.45	8.17	8.74	6.43	4.62	4.74

* Precipitation included in that of following day.

Daily Rainfall in Inches at Ten Places in Massachusetts, Geographically selected — Continued.

March, 1900.

Day of Month.	Pittsfield.	Springfield.	Amherst.	Fitchburg.	Worcester.	Lawrence.	Chestnut Hill.	Brockton.	New Bedford.	Barnstable.
1, .	0.16	*	2.36	2.81	2.98	*	1.89	1.70	*	0.76
2, .	1.68	2.81	0.42	0.41	-	2.22	-	-	0.90	-
3, .	0.05	-	-	-	-	-	-	-	-	-
4, .	-	-	-	-	-	-	-	-	-	-
5, .	-	0.05	0.05	0.06	0.05	0.05	0.04	-	0.12	-
6, .	0.37	*	0.74	0.64	*	*	0.44	0.33	*	0.13
7, .	0.20	0.50	-	0.09	0.32	0.62	-	-	0.29	0.10
8, .	-	-	-	-	-	-	-	-	-	-
9, .	-	-	-	-	-	-	-	-	-	-
10, .	-	-	-	-	-	-	-	-	-	-
11, .	-	-	-	-	-	-	-	-	-	-
12, .	-	-	-	-	-	-	-	-	-	-
13, .	-	-	-	-	-	-	-	-	-	-
14, .	-	-	-	-	-	-	-	-	-	-
15, .	-	*	*	0.08	*	*	*	*	*	-
16, .	1.37	1.97	2.17	2.10	2.44	2.35	2.19	2.00	1.24	1.01
17, .	-	-	-	-	-	-	-	-	-	-
18, .	-	-	-	-	-	-	-	-	-	-
19, .	-	*	0.15	-	*	*	*	*	*	0.25
20, .	-	0.32	-	0.20	0.30	0.10	0.23	0.38	0.92	0.45
21, .	-	-	-	-	-	-	-	-	-	-
22, .	-	-	-	-	-	-	-	-	-	-
23, .	-	-	-	-	-	-	-	-	-	-
24, .	-	-	-	-	-	-	-	-	-	-
25, .	-	-	-	-	-	-	-	-	-	-
26, .	-	*	0.22	0.09	*	*	*	-	*	-
27, .	-	0.20	-	0.07	0.18	0.19	0.24	-	0.16	0.21
28, .	-	-	-	-	-	-	-	-	-	-
29, .	-	-	-	-	-	-	-	-	-	-
30, .	-	-	-	-	-	-	-	*	-	-
31, .	-	-	-	-	-	-	-	0.17	0.10	0.10
Tot.,	3.83	5.85	6.11	6.55	6.27	5.53	5.03	4.58	3.73	3.01

April, 1900.

Day of Month.	Pittsfield.	Springfield.	Amherst.	Fitchburg.	Worcester.	Lawrence.	Chestnut Hill.	Brockton.	New Bedford.	Barnstable.
1, .	-	-	-	-	-	-	-	-	-	-
2, .	-	-	-	-	-	-	-	-	-	-
3, .	-	-	-	0.35	0.39	0.42	0.46	0.32	0.41	0.50
4, .	-	-	-	-	-	-	-	-	-	-
5, .	-	-	-	-	-	-	-	-	-	-
6, .	-	-	-	-	-	-	-	-	-	-
7, .	-	-	-	-	-	-	-	-	-	-
8, .	-	-	-	-	-	-	-	-	-	-
9, .	-	-	-	-	-	-	-	-	-	-
10, .	-	-	-	-	-	-	-	-	-	-
11, .	-	-	-	-	-	-	-	-	-	-
12, .	-	0.44	0.45	0.50	0.57	*	*	0.43	*	0.73
13, .	-	-	0.01	0.03	-	0.48	0.55	0.08	*	0.91
14, .	0.45	-	-	-	-	-	-	-	1.11	-
15, .	-	-	-	-	-	-	-	-	-	-
16, .	-	-	-	-	-	-	-	-	-	-
17, .	0.94	*	0.25	0.21	0.16	*	*	0.03	*	-
18, .	0.28	0.40	0.60	0.32	0.30	*	*	*	*	0.04
19, .	-	0.34	0.18	0.46	0.69	0.79	0.74	0.47	0.52	0.55
20, .	-	-	-	-	-	-	-	-	-	-
21, .	-	-	-	-	-	-	*	-	-	-
22, .	-	0.03	0.07	0.05	*	*	*	-	0.41	0.64
23, .	0.38	-	0.17	0.10	0.13	*	0.38	0.04	-	0.02
24, .	0.22	-	-	0.04	0.24	0.09	-	0.12	0.21	-
25, .	-	-	-	-	-	-	-	-	-	-
26, .	-	-	-	-	-	-	-	-	-	-
27, .	-	-	-	-	-	-	-	-	-	0.04
28, .	-	-	-	-	-	-	0.07	0.03	-	-
29, .	-	-	-	-	-	-	-	-	-	-
30, .	-	0.04	0.07	0.04	0.08	0.01	0.04	0.07	-	-
Tot.,	2.27	1.25	1.80	2.10	2.56	1.79	2.24	1.59	2.66	3.43

* Precipitation included in that of following day.

Daily Rainfall in Inches at Ten Places in Massachusetts, Geographically selected — Continued.

May, 1900.

Day of Month.	Pittsfield.	Springfield.	Amherst.	Fitchburg.	Worcester.	Lawrence.	Chestnut Hill.	Brockton.	New Bedford.	Barnstable.
1, .	-	-	-	-	-	-	-	-	-	-
2, .	-	-	0.72	-	-	-	-	-	-	-
3, .	-	*	0.30	0.76	1.44	1.57	2.47	2.70	3.48	1.38
4, .	-	1.25	0.08	0.10	-	0.12	0.08	0.12	0.09	0.06
5, .	0.10	0.03	-	0.03	0.03	0.02	-	-	-	-
6, .	-	-	-	-	-	-	-	0.05	0.07	-
7, .	-	-	-	-	-	-	-	-	0.07	0.09
8, .	-	0.68	0.48	0.03	0.27	0.12	0.08	0.19	0.22	0.18
9, .	-	-	0.30	0.13	0.17	0.20	0.26	0.22	0.04	0.23
10, .	-	-	-	-	-	-	-	-	0.22	-
11, .	-	-	-	-	-	-	-	-	-	-
12, .	-	-	-	-	-	-	-	-	-	-
13, .	-	-	-	-	-	-	-	-	-	-
14, .	-	-	-	-	-	-	-	-	0.07	-
15, .	-	0.01	0.03	0.08	0.07	0.29	0.39	-	-	0.25
16, .	0.13	-	-	-	-	-	-	-	-	-
17, .	1.00	-	-	0.02	*	-	-	-	-	-
18, .	-		-	0.65	*	*	*	*	-	0.03
19, .	1.54	3.10	2.09	1.01	1.48	*	2.02	2.25	-	0.43
20, .	0.22	-	0.01	-	-	1.29	-	-	1.04	0.03
21, .	-	-	-	0.02	0.01	0.27	0.11	0.08	-	-
22, .	-	-	-	-	-	-	-	-	-	-
23, .	-	-	-	-	-	-	-	-	-	-
24, .	-	-	-	-	-	-	-	-	-	-
25, .	-	-	-	-	-	-	-	-	-	-
26, .	-	-	-	-	-	-	-	-	0.01	0.08
27, .	-	-	-	-	-	-	-	-	-	-
28, .	-	-	-	-	-	0.02	-	-	-	-
29, .	-	-	-	-	-	-	-	-	-	-
30, .	-	-	-	-	-	-	-	-	-	-
31, .	-	-	-	-	-	-	-	-	-	-
Tot.,	2.99	5.07	4.01	2.83	3.47	3.90	5.41	5.61	5.31	2.76

June, 1900.

Day of Month.	Pittsfield.	Springfield.	Amherst.	Fitchburg.	Worcester.	Lawrence.	Chestnut Hill.	Brockton.	New Bedford.	Barnstable.
1, .	-	-	-	-	-	-	-	-	-	-
2, .	-	-	-	-	-	-	-	-	-	-
3, .	0.56	0.75	0.35	0.94	1.10	0.52	1.15	1.83	-	0.21
4, .	-	-	-	-	-	-	-	-	0.12	0.14
5, .	-	-	-	-	-	-	-	-	-	-
6, .	-	-	-	-	-	-	-	-	-	-
7, .	-	-	-	-	-	-	-	-	-	-
8, .	0.05	0.26	0.02	0.07	0.07	*	0.14	*	-	-
9, .	-	-	-	-	-	0.12	-	0.68	0.07	0.03
10, .	-	-	-	-	-	-	-	-	-	-
11, .	1.00	0.44	0.22	0.13	0.09	0.07	-	-	-	-
12, .	-	-	-	-	-	-	-	-	-	-
13, .	-	-	-	-	-	-	-	-	-	-
14, .	0.16	0.43	0.38	0.15	0.26	0.37	0.08	0.15	0.35	0.27
15, .	-	-	-	-	-	-	-	-	-	-
16, .	-	-	-	-	-	-	-	-	-	-
17, .	-	0.03	-	-	0.01	-	-	-	-	-
18, .	-	-	-	-	-	-	-	-	-	-
19, .	-	-	-	-	-	-	-	-	-	-
20, .	-	-	-	-	-	-	-	-	-	-
21, .	-	-	-	-	-	-	*	-	-	-
22, .	-	*	*	0.56	1.74	*	1.08	*	0.16	-
23, .	0.32	0.36	1.20	0.45	-	1.24	-	0.82	-	0.17
24, .	-	-	-	-	-	-	-	-	-	-
25, .	-	-	-	-	-	-	-	-	-	-
26, .	-	-	-	-	-	-	-	-	-	-
27, .	0.08	-	-	-	-	0.15	0.22	-	-	0.03
28, .	1.45	0.57	1.22	0.08	0.71	0.05	0.23	1.14	0.20	0.17
29, .	-	-	-	-	-	-	-	-	0.22	-
30, .	-	-	-	-	-	-	-	-	-	0.10
Tot.,	3.62	2.84	3.39	2.38	3.98	2.52	2.90	4.62	1.12	1.12

* Precipitation included in that of following day.

Daily Rainfall in Inches at Ten Places in Massachusetts, Geographically selected — Continued.

July, 1900.											August, 1900.										
Day of Month.	Pittsfield.	Springfield.	Amherst.	Fitchburg.	Worcester.	Lawrence.	Chestnut Hill.	Brockton.	New Bedford.	Barnstable.	Day of Month.	Pittsfield.	Springfield.	Amherst.	Fitchburg.	Worcester.	Lawrence.	Chestnut Hill.	Brockton.	New Bedford.	Barnstable.
1, .	–	–	–	–	–	–	–	–	–	–	1, .	–	–	–	–	–	–	–	–	0.31	0.01
2, .	–	–	–	–	–	–	–	–	–	–	2, .	–	–	–	–	–	–	–	–	–	–
3, .	–	–	–	–	0.02	0.03	0.05	0.08	–	0.02	3, .	–	–	–	–	–	–	–	–	–	–
4, .	–	–	–	–	–	–	–	–	0.15	–	4, .	0.22	–	–	–	–	–	–	–	–	–
5, .	–	–	–	–	–	–	–	–	–	–	5, .	–	–	–	–	–	–	–	–	–	–
6, .	–	–	0.75	0.13	0.02	0.05	0.07	0.09	–	–	6, .	0.40	0.29	0.05	–	0.05	0.25	–	–	–	–
7, .	0.70	0.11	0.21	0.05	0.06	–	0.02	–	–	–	7, .	0.32	0.10	0.43	0.11	*	*	*	0.18	–	0.03
8, .	0.22	–	0.06	0.20	0.01	–	–	–	–	–	8, .	–	*	1.39	0.99	1.20	0.37	0.33	0.07	0.29	–
9, .	–	0.05	0.31	0.08	–	0.11	0.05	–	–	–	9, .	–	0.21	–	–	–	–	–	–	–	0.28
10, .	0.03	–	–	–	–	–	–	–	–	–	10, .	–	–	0.03	–	0.12	0.51	0.10	–	–	–
11, .	–	–	–	–	–	–	–	–	–	–	11, .	–	–	–	–	–	–	–	–	–	–
12, .	0.30	0.43	0.50	0.32	0.56	0.39	0.56	0.48	0.42	0.26	12, .	–	–	–	0.06	0.02	0.07	–	–	–	–
13, .	–	–	–	–	–	–	–	–	–	–	13, .	0.34	*	0.14	0.03	*	*	–	*	–	–
14, .	–	–	–	–	–	–	–	–	–	–	14, .	–	0.10	0.05	0.10	0.28	0.10	0.34	0.10	–	–
15, .	0.22	0.06	0.35	–	0.07	–	–	–	0.08	–	15, .	2.16	0.25	0.80	0.42	0.70	0.27	0.39	0.32	0.14	0.07
16, .	–	–	–	–	–	–	–	–	–	–	16, .	1.07	0.30	1.15	1.81	0.19	1.44	0.72	0.30	0.09	0.01
17, .	–	–	–	–	–	–	–	–	–	–	17, .	–	0.20	–	–	–	–	–	0.10	–	–
18, .	–	0.01	–	0.37	0.02	0.03	0.20	0.08	0.03	–	18, .	–	–	–	–	–	–	–	–	0.33	–
19, .	–	–	–	–	–	–	–	–	–	–	19, .	–	–	–	–	0.10	–	0.07	0.03	–	0.09
20, .	–	–	–	–	–	–	–	–	–	–	20, .	–	–	–	–	–	–	–	–	–	–
21, .	0.05	0.33	1.64	0.07	0.04	0.07	–	–	–	–	21, .	–	–	–	–	–	–	–	–	–	–
22, .	–	–	–	–	–	–	–	–	–	–	22, .	–	–	–	–	0.02	–	–	–	0.21	0.10
23, .	–	–	–	–	–	–	–	–	0.06	–	23, .	–	–	–	–	–	–	–	–	–	–
24, .	–	0.07	–	–	0.06	–	–	0.09	0.23	0.05	24, .	–	0.10	–	–	0.07	–	0.03	–	*	0.57
25, .	–	0.02	0.36	0.95	*	*	*	*	1.60	0.18	25, .	–	–	–	–	–	–	–	–	0.26	–
26, .	0.30	1.33	0.45	0.49	2.63	1.40	1.73	2.20	–	0.71	26, .	–	–	–	–	–	–	–	–	–	–
27, .	0.30	–	–	–	–	–	–	–	–	–	27, .	0.18	–	–	–	–	0.02	–	–	–	–
28, .	–	–	–	–	–	–	–	–	–	–	28, .	–	0.07	0.03	–	0.01	–	0.17	0.08	–	0.20
29, .	–	–	–	–	–	–	–	–	–	–	29, .	–	–	0.09	0.11	–	0.51	–	–	–	–
30, .	–	0.03	0.02	–	–	–	–	–	–	–	30, .	–	–	–	–	–	–	–	–	–	–
31, .	–	–	–	–	–	–	–	–	–	–	31, .	–	–	–	–	–	–	–	–	–	–
Tot.,	2.12	2.44	4.65	2.66	3.49	2.08	2.68	3.02	2.57	1.22	Tot.,	4.69	1.62	4.16	3.63	2.76	3.54	2.15	1.18	1.63	1.36

* Precipitation included in that of following day.

Daily Rainfall in Inches at Ten Places in Massachusetts, Geographically selected — Continued.

September, 1900.											October, 1900.										
Day of Month.	Pittsfield.	Springfield.	Amherst.	Fitchburg.	Worcester.	Lawrence.	Chestnut Hill.	Brockton.	New Bedford.	Barnstable.	Day of Month.	Pittsfield.	Springfield.	Amherst.	Fitchburg.	Worcester.	Lawrence.	Chestnut Hill.	Brockton.	New Bedford.	Barnstable.
1, .	-	-	-	-	-	-	-	-	-	-	1, .	-	-	-	-	-	-	-	-	-	0.03
2, .	-	-	-	-	-	-	-	-	-	-	2, .	-	-	-	-	-	-	-	-	0.01	-
3, .	-	-	-	-	-	-	-	-	-	-	3, .	-	-	-	-	-	-	-	-	-	0.02
4, .	-	-	-	-	-	-	-	-	-	-	4, .	-	-	-	-	-	-	-	-	-	0.01
5, .	-	-	-	-	-	-	-	-	-	-	5, .	-	-	-	-	-	-	-	-	-	-
6, .	-	0.04	-	-	-	0.03	-	-	0.02	-	6, .	-	-	-	-	-	-	-	-	-	0.01
7, .	-	-	-	-	-	-	-	-	-	-	7, .	-	*	-	0.01	-	-	0.07	-	0.02	0.02
8, .	-	-	-	-	-	-	-	-	-	-	8, .	-	*	0.52	1.08	0.59	-	*	-	-	-
9, .	-	-	-	-	-	-	-	-	-	-	9, .	0.57	*	0.50	0.98	0.79	-	2.17	1.14	1.00	0.88
10, .	-	-	-	-	-	-	-	-	-	-	10, .	0.05	*	0.58	0.68	0.13	-	-	0.12	1.32	0.68
11, .	-	-	-	-	-	0.02	-	-	-	-	11, .	0.45	2.14	0.16	0.12	-	2.30	0.17	-	0.09	0.03
12, .	-	-	-	-	-	-	-	-	-	-	12, .	-	-	-	-	-	-	-	-	-	-
13, .	-	-	-	-	-	-	-	-	-	-	13, .	-	-	-	*	-	-	*	*	*	1.00
14, .	-	-	-	-	-	-	-	-	-	-	14, .	0.24	0.51	0.45	0.41	-	*	0.56	0.75	1.01	1.12
15, .	0.90	-	*	-	-	-	*	-	-	-	15, .	-	-	-	-	-	0.19	-	-	0.03	-
16, .	-	1.46	1.70	1.00	1.19	1.00	1.35	2.03	2.62	3.04	16, .	-	0.06	0.09	0.03	-	0.18	0.17	0.10	-	0.08
17, .	0.21	0.08	0.15	0.46	*	*	*	0.10	0.02	0.02	17, .	0.10	-	-	-	-	-	-	-	-	-
18, .	-	-	0.63	1.16	0.37	1.80	2.02	2.08	0.82	0.31	18, .	-	-	-	-	-	-	0.04	-	-	-
19, .	-	0.33	-	-	-	-	-	-	-	-	19, .	-	-	-	-	-	-	-	-	-	-
20, .	0.32	-	*	-	-	-	-	0.03	-	-	20, .	-	-	-	-	-	-	-	-	-	-
21, .	-	0.08	0.31	0.43	0.21	0.13	*	*	-	-	21, .	-	-	-	-	-	-	-	-	-	-
22, .	0.05	-	-	0.04	-	0.25	0.47	0.18	0.22	0.04	22, .	-	-	-	-	-	-	-	-	-	-
23, .	0.03	-	-	-	-	-	-	-	-	0.04	23, .	-	-	0.30	-	-	-	-	-	0.28	-
24, .	-	-	-	-	-	-	-	-	-	-	24, .	0.24	0.17	-	0.13	0.13	0.02	0.08	0.15	-	0.11
25, .	-	-	-	-	-	-	-	-	-	-	25, .	-	-	-	-	-	-	-	-	-	-
26, .	0.10	-	*	-	-	-	-	-	-	-	26, .	0.30	-	-	-	-	-	-	-	-	-
27, .	-	-	0.22	0.56	0.23	0.02	-	-	-	-	27, .	0.57	*	0.76	0.02	0.17	-	*	-	*	-
28, .	-	-	-	0.04	0.02	0.02	0.12	-	-	-	28, .	-	0.72	0.01	0.12	0.04	*	0.53	1.18	2.80	0.29
29, .	0.28	-	-	-	-	-	-	-	-	0.02	29, .	-	-	-	-	-	0.04	-	-	0.02	0.03
30, .	-	0.53	0.39	0.40	0.19	0.12	0.16	0.38	0.49	-	30, .	-	-	-	-	-	-	-	-	-	-
											31, .	-	-	-	-	-	-	-	-	-	-
Tot.,	1.89	2.52	3.40	4.09	2.21	3.39	4.12	4.80	4.19	3.47	Tot.,	2.52	3.60	3.37	3.58	1.85	2.73	3.79	3.44	6.58	4.31

* Precipitation included in that of following day.

Daily Rainfall in Inches at Ten Places in Massachusetts, Geographically selected — Continued.

November, 1900.										
Day of Month.	Pittsfield.	Springfield.	Amherst.	Fitchburg.	Worcester.	Lawrence.	Chestnut Hill	Brockton.	New Bedford.	Barnstable.
1, ...	-	*	0.03	-	-	0.02	-	-	-	-
2, ...	-	0.04	-	-	-	-	-	-	-	0.04
3, ...	-	-	-	-	-	-	-	-	0.43	0.39
4, ...	-	-	-	-	-	-	-	-	-	-
5, ...	-	-	-	-	-	-	-	-	-	-
6, ...	-	-	-	-	-	-	-	-	-	-
7, ...	0.18	-	-	-	-	-	-	-	-	-
8, ...	-	1.33	1.07	1.55	0.87	0.25	0.41	0.20	0.33	0.65
9, ...	1.23	0.62	0.68	0.63	0.52	1.00	0.62	0.50	0.70	0.48
10, ...	-	-	-	-	-	-	-	-	-	-
11, ...	-	-	-	-	-	-	-	-	0.11	-
12, ...	-	-	-	-	-	-	-	-	-	0.46
13, ...	-	-	-	-	-	-	-	-	-	-
14, ...	-	-	-	-	-	-	-	-	-	-
15, ...	-	0.01	-	-	-	-	0.03	0.09	0.05	0.10
16, ...	-	-	-	-	-	-	-	-	-	-
17, ...	-	-	0.01	-	-	0.01	-	-	-	-
18, ...	0.25	0.04	-	0.01	-	-	-	-	0.05	-
19, ...	0.14	*	-	0.15	0.13	-	-	0.06	0.13	-
20, ...	0.17	0.13	-	0.15	0.06	0.39	0.25	0.24	0.09	0.37
21, ...	-	0.07	0.42	0.20	0.05	0.28	0.07	-	0.03	0.03
22, ...	0.33	-	0.03	-	0.08	-	-	-	-	0.02
23, ...	-	0.05	-	-	-	-	0.08	-	-	-
24, ...	-	*	-	-	0.10	-	-	-	0.03	-
25, ...	1.38	*	1.08	0.72	0.88	*	*	0.05	1.00	1.29
26, ...	-	*	2.10	1.90	1.46	*	2.93	*	0.40	0.90
27, ...	0.25	3.23	0.05	0.08	0.08	*	0.06	2.88	0.62	0.04
28, ...	-	-	-	-	0.20	2.04	-	-	0.08	-
29, ...	0.45	-	-	0.04	0.26	-	-	*	-	0.05
30, ...	-	0.34	0.42	0.48	-	0.43	0.85	0.88	0.60	0.28
Totals, . .	4.38	5.86	5.89	5.91	4.69	4.42	5.30	4.90	4.65	5.10

* Precipitation included in that of following day.

Daily Rainfall in Inches at Ten Places in Massachusetts, Geographically selected — Continued.

December, 1900.

Day of Month.	Pittsfield.	Springfield.	Amherst.	Fitchburg.	Worcester.	Lawrence.	Chestnut Hill.	Brockton.	New Bedford.	Barnstable.
1,	-	-	-	-	-	-	-	-	-	-
2,	-	-	-	-	-	-	-	-	-	-
3,	-	-	-	-	-	-	-	-	-	-
4,	-	*	1.10	1.08	1.34	*	*	1.58	*	1.18
5,	1.28	2.09	0.61	1.12	0.52	1.91	1.91	-	1.50	-
6,	-	-	-	-	-	-	-	-	0.05	0.02
7,	-	-	-	-	-	-	-	-	-	-
8,	-	-	-	-	-	-	-	-	-	-
9,	-	-	-	-	0.05	-	-	-	-	0.02
10,	-	-	-	-	-	-	-	-	-	-
11,	-	0.03	-	-	0.03	-	-	-	0.03	0.02
12,	-	-	-	-	-	-	-	-	-	-
13,	-	-	-	-	-	-	-	-	-	-
14,	-	-	-	-	-	-	-	-	-	-
15,	-	-	-	-	-	-	-	-	-	-
16,	-	-	-	0.02	0.03	-	0.05	-	-	-
17,	-	-	-	-	-	-	-	-	-	-
18,	-	-	-	-	-	-	-	-	-	-
19,	-	-	-	-	-	-	-	-	-	-
20,	-	-	-	-	-	-	-	-	-	-
21,	-	-	-	-	-	-	-	-	*	-
22,	-	-	-	-	-	-	-	-	0.17	0.44
23,	-	-	-	-	-	*	-	*	-	-
24,	0.38	0.23	0.76	0.34	0.21	0.24	0.31	0.40	0.42	0.38
25,	-	-	-	-	-	-	-	-	-	-
26,	-	-	-	-	-	-	-	-	-	-
27,	-	-	-	-	-	-	-	-	-	-
28,	0.14	0.07	0.10	0.04	0.04	0.04	0.08	-	0.15	0.11
29,	-	-	-	-	-	-	-	0.08	-	-
30,	0.28	-	-	-	-	-	*	*	-	-
31,	-	0.34	0.29	0.20	0.28	0.23	0.50	0.32	0.37	0.41
Totals,	2.08	2.76	2.86	2.80	2.50	2.41	2.85	2.38	2.69	2.58
Totals for the year,	41.08	46.10	52.68	49.98	44.36	45.58	49.59	46.66	44.99	38.65

* Precipitation included in that of following day.

Flow of Streams.

The flow of streams for the year 1900, as indicated by the records of the Sudbury River, was very slightly in excess of the normal. The flow during the months of February, March, May and December was in excess of, and during the remaining months was less than, the normal. In the months of July and August the flow of the Sudbury River was less than the evaporation from the water surfaces, so that the flow is represented by a minus quantity. The flow during the six driest months was more than twice as great as the flow during the six driest months of 1899.

In order to show the relation between the flow of the Sudbury River during each month of 1900 and the normal flow of the same river as deduced from twenty-six years' observations, from 1875 to 1900 inclusive, the following table has been prepared. The area of the water-shed of the Sudbury River above the point of measurement is 75.2 square miles.

Table showing the Average Monthly Flow of Sudbury River for the Year 1900 in Cubic Feet per Second per Square Mile of Drainage Area and in Gallons per Day per Square Mile of Drainage Area, also Departures from the Normal Flow.

Month.	Normal Flow.		Actual Flow in 1900.		Excess or Deficiency.	
	Cubic Feet per Second per Square Mile.	Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Gallons per Day per Square Mile.
January,	1.909	1,234,000	1.229	794,000	—0.680	—440,000
February,	3.017	1,950,000	5.880	3,800,000	+2.863	+1,850,000
March,	4.532	2,929,000	5.653	3,654,000	+1.121	+725,000
April,	3.083	1,993,000	2.088	1,350,000	—0.995	—643,000
May,	1.692	1,094,000	2.031	1,312,000	+0.339	+218,000
June,	0.726	469,000	0.489	316,000	—0.237	—153,000
July,	0.293	189,000	—0.028	—18,000	—0.321	—207,000
August,	0.458	296,000	—0.052	—34,000	—0.510	—330,000
September,	0.365	236,000	0.101	65,000	—0.264	—171,000
October,	0.808	522,000	0.287	186,000	—0.521	—336,000
November,	1.457	942,000	1.026	663,000	—0.431	—279,000
December,	1.615	1,044,000	1.696	1,096,000	+0.081	+52,000
Average,	1.655	1,070,000	1.674	1,082,000	+0.019	+12,000

The next table shows the weekly fluctuations during 1900 in the flow of two of the streams which were carefully measured, namely, the Sudbury and the Merrimack. The flow of these streams, particularly the Sudbury, serves to indicate the flow of the other streams in eastern Massachusetts.

Week ending Sunday.	Sudbury River. Cubic Feet per Second per Square Mile.	Merrimack River. Cubic Feet per Second per Square Mile.	Week ending Sunday.	Sudbury River. Cubic Feet per Second per Square Mile.	Merrimack River. Cubic Feet per Second per Square Mile.
1900.			**1900.**		
Jan. 7,	0.115	0.422	July 8,	—0.026	0.376
14,	0.796	0.429	15,	—0.065	0.426
21,	1.212	0.507	22,	—0.265	0.397
28,	1.625	1.396	29,	0.311	0.403
Feb. 4,	2.057	0.965	Aug. 5,	—0.264	0.411
11,	4.217	1.530	12,	0.098	0.337
18,	8.237	6.671	19,	0.332	0.484
25,	7.454	3.609	26,	—0.148	0.443
March 4,	12.709	6.045	Sept. 2,	—0.261	0.357
11,	3.728	3.678	9,	—0.204	0.320
18,	5.955	2.530	16,	—0.109	0.279
25,	4.095	3.601	23,	0.424	0.362
April 1,	1.789	2.514	30,	0.322	0.407
8,	2.447	3.651	Oct. 7,	0.067	0.424
15,	1.993	3.493	14,	0.818	0.652
22,	2.463	5.223	21,	0.346	0.622
29,	1.778	4.342	28,	0.012	0.502
May 6,	2.848	2.732	Nov. 4,	0.107	0.461
13,	1.805	2.143	11,	0.320	1.137
20,	2.416	1.931	18,	0.386	1.172
27,	1.641	2.522	25,	0.454	1.133
June 3,	0.852	1.230	Dec. 2,	3.316	2.363
10,	1.381	1.314	9,	3.426	2.504
17,	0.247	0.812	16,	1.533	1.243
24,	0.241	0.645	23,	0.907	0.867
July 1,	0.143	0.526	30,	1.063	1.299

The following table gives the rainfall upon the Sudbury River water-shed and its total yield, expressed in inches in depth on the water-shed (inches of rainfall collected), for the year 1900, together with the average of the records of twenty-six years, from 1875 to 1900, inclusive: —

Rainfall in Inches, received and collected on Sudbury Water-shed.

Month.	1900.			Mean for 26 Years, 1875-1900.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	4.96	1.417	28.6	4.35	2.202	50.6
February,	9.14	6.123	67.0	4.44	3.168	71.3
March,	6.35	6.518	102.6	4.48	5.227	116.6
April,	2.58	2.330	90.3	3.22	3.441	106.9
May,	4.32	2.341	54.2	3.37	1.952	57.9
June,	2.99	0.545	18.2	2.93	0.810	27.6
July,	2.42	—0.032	—1.3	3.72	0.337	9.1
August,	2.26	—0.060	—2.7	4.09	0.528	12.9
September,	3.36	0.112	3.3	3.24	0.407	12.6
October,	3.83	0.331	8.7	4.35	0.932	21.4
November,	5.70	1.144	20.1	4.27	1.625	38.1
December,	2.74	1.955	71.5	3.55	1.862	52.4
Totals and averages,	50.65	22.724	44.9	46.01	22.419	48.9

The Sudbury River records are particularly valuable as a basis for estimating the yield of other water-sheds in Massachusetts, both on account of the accuracy with which the measurements have been made and the absence of abnormal conditions which would unfavorably affect the results. The following table gives the records relating to the yield of this water-shed for each of the past twenty-six years, the flow from the water-shed being expressed in gallons per day per square mile, instead of inches in depth of rainfall collected, in order to render the table more convenient for use in estimating the probable yield of water-sheds used as sources of water supply: —

*Yield of the Sudbury River Water-shed in Gallons per Day per Square Mile.**

Month.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.
January,	103,000	643,000	658,000	1,810,000	700,000	1,121,000	415,000	1,241,000	335,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000	2,403,000	1,033,000
March,	1,604,000	4,435,000	4,813,000	3,507,000	2,330,000	1,374,000	4,004,000	2,839,000	1,611,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,168,000	1,546,000	867,000	1,350,000
May,	1,188,000	1,139,000	1,391,000	1,394,000	1,114,000	514,000	965,000	1,292,000	938,000
June,	870,000	222,000	597,000	506,000	413,000	176,000	1,338,000	529,000	300,000
July,	321,000	183,000	202,000	128,000	158,000	177,000	276,000	86,000	115,000
August,	396,000	405,000	121,000	475,000	395,000	119,000	148,000	55,000	78,000
September,	207,000	184,000	60,000	160,000	141,000	80,000	197,000	306,000	91,000
October,	646,000	234,000	632,000	516,000	71,000	101,000	186,000	299,000	186,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000	210,000	205,000
December,	584,000	454,000	1,289,000	3,177,000	462,000	175,000	775,000	314,000	193,000
Av. for whole year,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000	979,000	862,000	533,000
Av. for driest six months.	574,000	384,000	502,000	532,000	230,000	143,000	330,000	211,000	145,000

Month.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
January,	995,000	1,235,000	1,461,000	2,589,000	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000
February,	2,842,000	1,354,000	4,800,000	2,829,000	1,951,000	1,195,000	1,529,000	3,486,000	943,000
March,	3,785,000	1,572,000	2,059,000	2,868,000	3,237,000	1,339,000	3,643,000	4,453,000	1,955,000
April,	2,853,000	1,815,000	1,947,000	2,620,000	2,645,000	1,410,000	1,875,000	2,397,000	871,000
May,	1,030,000	1,336,000	720,000	1,009,000	1,632,000	880,000	1,366,000	582,000	1,259,000
June,	417,000	426,000	203,000	414,000	422,000	653,000	568,000	414,000	428,000
July,	224,000	62,000	115,000	114,000	117,000	633,000	108,000	149,000	214,000
August,	257,000	240,000	94,000	214,000	380,000	1,432,000	132,000	163,000	280,000
September,	44,000	121,000	118,000	111,000	1,155,000	824,000	458,000	203,000	229,000
October,	83,000	336,000	146,000	190,000	1,999,000	1,230,000	2,272,000	210,000	126,000
November,	175,000	1,178,000	673,000	368,000	2,758,000	1,941,000	1,215,000	305,000	697,000
December,	925,000	1,174,000	1,020,000	643,000	3,043,000	2,241,000	997,000	544,000	485,000
Av. for whole year,	1,129,000	901,000	1,087,000	1,154,000	1,697,000	1,383,000	1,285,000	1,315,000	781,000
Av. for driest six months.	200,000	391,000	223,000	234,000	953,000	944,000	747,000	239,000	327,000

Month.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	Mean for 26 Years, 1875 to 1900, inclusive.
January,	433,000	693,000	1,034,000	1,084,000	845,000	1,638,000	2,288,000	794,000	1,234,000
February,	1,542,000	991,000	541,000	2,676,000	1,067,000	3,022,000	1,381,000	3,800,000	1,950,000
March,	3,245,000	2,238,000	2,410,000	3,835,000	2,565,000	2,604,000	4,205,000	3,654,000	2,929,000
April,	2,125,000	1,640,000	2,515,000	1,494,000	1,515,000	1,829,000	2,521,000	1,350,000	1,993,000
May,	2,883,000	840,000	636,000	360,000	915,000	1,246,000	511,000	1,312,000	1,094,000
June,	440,000	419,000	174,000	399,000	962,000	530,000	66,000	316,000	469,000
July,	158,000	161,000	231,000	95,000	658,000	231,000	19,000	—18,000	189,000
August,	181,000	209,000	229,000	57,000	591,000	1,107,000	—35,000	—34,000	296,000
September,	108,000	150,000	89,000	388,000	182,000	369,000	94,000	65,000	236,000
October,	221,000	374,000	1,379,000	592,000	94,000	1,160,000	115,000	186,000	522,000
November,	319,000	836,000	2,777,000	659,000	909,000	1,986,000	304,000	663,000	942,000
December,	797,000	716,000	1,782,000	657,000	1,584,000	1,799,000	220,000	1,096,000	1,044,000
Av. for whole year,	1,037,000	770,000	1,152,000	1,019,000	991,000	1,450,000	973,000	1,082,000	1,070,000
Av. for driest six months.	237,000	356,000	460,000	314,000	564,000	777,000	93,000	194,000	440,000

* The area of the Sudbury River water-shed used in making up these records included water surfaces amounting to about 1 per cent. of the whole area, from 1875 to 1878 inclusive, subsequently increasing by the construction of storage reservoirs to about 3 per cent. in 1886, to 3.5 per cent. in 1894 and to about 6 per cent. in 1898. The water-shed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

EXPERIMENTS

UPON THE

PURIFICATION OF SEWAGE AND WATER

AT THE

LAWRENCE EXPERIMENT STATION,

DURING THE YEAR 1900.

EXPERIMENTS UPON THE PURIFICATION OF SEWAGE AND WATER AT THE LAWRENCE EXPERIMENT STATION.*

By Harry W. Clark, *Chemist of the Board.*

The following report presents a summary of the investigations upon the purification of sewage and water during the year 1900 and the results obtained. Much other work has been done at the station during the year upon allied lines of investigation, such as the bacteriology of spring waters and ice, a bacterial study of the danger of infection from eating shell-fish taken from sewage-polluted sources, etc.

Purification of Sewage.

A number of interesting investigations upon rapid methods of sewage purification have been continued during the year, together with studies of the varying character of the sewage flowing from septic tanks operated under different conditions. The apparent inability of contact filters to successfully purify septic sewage of a certain character has given rise to some studies of this problem, these being outlined beyond and explaining to a certain extent the cause of the unsatisfactory work of these filters. Experiments upon the purification of waste liquors from tanneries and wool washing establishments have been continued during the year; the varying character of these liquors flowing from different plants, where the process carried on varies somewhat, making the question of their successful disposal an interesting one. It is also a valuable study, as these wastes, together with those from paper mills, are the three principal manufactural liquors that pollute several of the rivers of the State.

* The work has been carried on under the general supervision of Hiram F. Mills, A.M., C.E., member of the State Board of Health, with the writer in direct charge. A full account of the work done at the Lawrence Experiment Station for the years 1888 and 1889 is contained in a special report of the State Board of Health upon the purification of sewage and water, 1890. A similar account for the years 1890 and 1891 is contained in the twenty-third annual report of the Board for 1891. Since 1891 the results have been published yearly in the annual reports.

The three following tables show the general character and composition of the Lawrence sewage, as it flows in the sewer from which it is obtained and as it arrives at the station after passing slowly through a 2½-inch pipe, 4,300 feet long, much of which is laid in the bed of the Merrimack River. Sewage has been obtained generally in sufficient quantities for our investigations during the year, except for a period from November 26 to December 16 inclusive, when this pipe from the sewer was broken and could not be repaired, owing to high water in the river.

Monthly Averages of Analyses of Sewage from the Lawrence Street Sewer.

[Parts per 100,000.]

1900.	Temperature. Deg. F.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
January,	51	4.03	1.28	.79	.49	9.18	.141	.0175	13.75	2,860,000
February,	49	3.55	1.11	.67	.44	8.12	.168	.0110	10.05	1,520,000
March,	50	2.64	0.92	.54	.38	9.04	.182	.0126	9.08	1,814,000
April,	55	3.03	0.95	.55	.40	13.98	.158	.0135	8.30	2,320,000
May,	60	3.18	0.84	.54	.30	8.26	.167	.0083	7.56	2,334,000
June,	69	3.05	0.63	.40	.23	9.52	.077	.0255	6.35	2,530,000
July,	72	3.30	0.88	.43	.45	9.71	.168	.0020	7.78	3,150,000
August,	73	3.70	0.92	.49	.43	13.38	.119	.0036	7.22	2,645,000
September,	69	3.80	1.05	.48	.57	12.43	.061	.0112	7.13	6,485,000
October,	62	3.35	0.88	.52	.36	12.32	.095	.0298	16.43	3,178,000
November,	63	3.18	0.92	.60	.32	23.99	.124	.0125	8.58	1,710,000
December,	53	4.08	1.22	.72	.50	11.74	.226	.0140	8.73	4,060,000
Average,	61	3.41	0.97	.56	.41	11.81	.141	.0135	9.25	2,884,000

Monthly Averages of Regular Station Sewage Samples.

[Parts per 100,000.]

1900.	Temperature. Deg. F.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Total.	In Solution.	In Suspension.			
January,	46	4.19	.81	.38	.43	7.18	5.75	2,228,000
February,	46	2.76	.43	.24	.19	4.79	3.35	1,950,000
March,	46	2.23	.57	.18	.39	4.16	3.50	1,493,000
April,	46	4.37	.88	.36	.52	8.07	5.03	3,554,000
May,	53	4.56	.60	.33	.27	8.68	4.02	2,646,000
June,	67	4.84	.70	.30	.40	10.37	4.20	2,507,000
July,	72	4.70	.62	.28	.34	11.61	3.99	2,789,000
August,	72	4.25	.52	.24	.28	12.27	3.06	2,171,000
September,	67	4.76	.63	.26	.37	10.98	3.20	3,113,000
October,	59	4.52	.67	.29	.38	9.76	3.69	3,279,000
November,	53	4.35	.71	.30	.41	10.03	4.68	2,807,000
December,	49	4.76	.95	.42	.53	8.46	6.10	4,266,000
Average,	56	4.19	.67	.30	.37	8.86	4.21	2,734,000

Monthly Averages of Mixed Samples representing all of the Sewage applied to Filters Nos. 1, 6 and 9 A.

[Parts per 100,000.]

1900.	Free Ammonia.			Albuminoid Ammonia.			Chlorine.			Oxygen Consumed.		
	Filter No. 1.	Filter No. 6.	Filter No. 9A.	Filter No. 1.	Filter No. 6.	Filter No. 9A.	Filter No. 1.	Filter No. 6.	Filter No. 9A.	Filter No. 1.	Filter No. 6.	Filter No. 9A.
January, ...	4.23	4.70	3.97	.78	.80	0.87	7.98	8.13	7.73	5.80	6.57	6.27
February, . . .	3.33	3.83	3.50	.68	.80	0.70	5.54	6.40	5.57	5.30	5.43	4.90
March, ...	2.51	2.08	2.45	.50	.45	0.54	5.15	4.58	4.86	3.27	2.85	3.70
April, ...	4.80	4.70	4.77	.87	.70	1.01	8.60	7.61	8.19	4.80	3.85	5.73
May, ...	3.75	4.80	4.35	.74	.80	0.73	8.91	8.19	8.25	4.15	4.10	4.10
June, ...	4.72	4.50	4.80	.69	.59	0.76	11.57	10.11	10.01	4.86	4.52	4.90
July, ...	4.58	4.38	4.78	.55	.53	0.57	13.14	12.21	12.66	4.10	4.23	4.93
August, ...	4.70	4.27	4.60	.50	.50	0.60	12.55	11.34	11.85	3.81	3.69	3.52
September, . . .	4.73	4.83	4.75	.71	.65	0.72	12.51	12.57	13.27	3.88	3.59	3.60
October, . . .	4.63	5.05	5.08	.78	.77	0.90	10.83	11.36	10.28	4.90	3.99	4.69
November, . . .	4.88	5.10	5.28	.86	.82	1.02	9.17	10.56	10.21	5.15	4.86	5.52
December, . . .	4.30	4.75	4.85	.89	.79	0.86	8.94	8.50	9.26	6.01	5.63	6.24
Average, . .	4.26	4.42	4.43	.71	.68	0.77	9.57	9.30	9.35	4.67	4.44	4.84

Sewage applied to and Effluents from Coke and Coal Strainers.

The coke strainer, 15 inches in depth, that was put into operation Oct. 15, 1898, was continued until the end of 1900, at an average rate of 1,000,000 gallons per acre daily. The coke in this strainer was of such size that all would pass through a sieve with a ½-inch mesh, 80 per cent. through a sieve with a ¼-inch mesh, but was free from coke dust, in distinction from the strainer in operation up to Oct. 15, 1898. During its period of operation a volume of sewage equal to 720,000,000 gallons upon an acre was passed through it, and but 2 inches in depth of surface material had to be removed from it, or about .4 of a cubic yard per 1,000,000 gallons of sewage strained. During 1900 this strainer removed 44 per cent. of the organic matters in the sewage applied to it as shown by the albuminoid ammonia determinations, and 34 per cent. as shown by the determinations of oxygen consumed. The surface was raked twelve times during the year.

Coal Strainer.

The strainer of fine bituminous coal, put into operation during 1899, was continued throughout 1900. It was operated at the rate of 1,000,000 gallons per acre daily, and removed 41 per cent. of the organic matter in the sewage applied to it as shown by the albuminoid ammonia determinations, and 34 per cent. as shown by the determinations of oxygen consumed.

The following table shows the average analyses of the sewage applied to and the effluents from these strainers: —

Average Analyses of Sewage applied to and Effluents from Coke and Coal Strainers.

[Parts per 100,000.]

	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Total.	In Solution.	In Suspension.			
Sewage applied,	3.95	.66	.28	.38	9.58	4.20	2,833,000
Effluent of coke strainer,	3.94	.37	.22	.15	9.90	2.76	886,100
Effluent of coal strainer,	3.88	.39	.25	.14	9.90	2.79	1,010,600

Septic Sewage and its Purification.

The character of septic sewage and the results of experiments upon its purification have been discussed in the previous reports. Additional investigations have been carried on during the year with the following results: —

Septic Tank A, receiving Average City Sewage.

This tank experiment was begun during the latter part of 1897, and the results obtained up to Jan. 1, 1900, are given in previous reports. The construction of the tank during the first year and a half of its operation was as stated in the last report, but a change was made early in 1900, — the sewage and sludge in the old tank being transferred to the new one, — and as now constructed it is an air-tight wooden tank, divided by two partitions into three equal compartments. Floating partitions also prevent the passage from

one compartment to another of the scum on the surface of the sewage. The sewage flows through a pipe in the top of the tank, which empties midway between the top and bottom of the first compartment, and is withdrawn from the further end of the tank at the same depth, the pressure of a body of sewage in the feed tank above keeping the flow fairly constant. From January 1 to April 12 the sewage was seventeen hours in passing through the tank; from April 16 to April 30, twenty-one hours; and from May 1 to December 31, sixteen hours. The following determinations of the accumulation of sediment in the tank have been made, these determinations showing the percentage of total volume of the compartment filled with the sediment on the dates given: —

Percentage of Total Capacity of Septic Tank A filled with Sediment.

1900.	January 1 (Per Cent.).	May 24 (Per Cent.).	October 4 (Per Cent.).	December 31 (Per Cent.).
Inlet compartment,	22	22	19	33
Middle compartment,	–	33	14	22
Outlet compartment,	11	11	10	11

At the end of the year there was about ½ inch of floating matter on the top of the sewage in the inlet compartment, but not enough to be measured in the other two compartments of the tank. A comparison of the tables of the sewage entering and flowing from this tank shows a change or removal of about 60 per cent. of nitrogenous organic matter and 50 per cent. of carbonaceous matter by the bacterial and chemical action in the tank during the year. As was stated in the previous report, one of the most valuable functions of the tank is the hydrolysis and transformation into gases of cellulose in sewage, such as paper, rags, vegetable matter, etc. As an illustration of this, upon October 4 a considerable quantity of newspaper and cotton and woollen cloth was placed in this tank in wire baskets. Upon December 31 the cloth and paper were still intact, but so rotten that they fell to pieces when touched. The same substances upon the surface of a filter where oxidation is the principal action would probably have remained without much change for a much longer period.

A discussion upon the filtration of septic sewage is given beyond.

Sewage as it enters Septic Tank A.

[Parts per 100,000.]

1900.	Temperature. Deg. F.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. In Solution.	Albuminoid Ammonia. In Suspension.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	42	4.86	1.49	.39	1.10	9.98	9.91	4,360,000
February,	39	3.23	0.67	.24	0.43	4.07	4.83	1,415,000
March,	41	3.25	1.50	.22	1.28	5.29	7.46	1,963,000
April,	47	5.18	1.02	.37	0.65	9.11	5.00	2,656,000
May,	53	4.93	0.87	.31	0.56	8.45	4.28	1,810,000
June,	65	4.80	0.57	.24	0.33	11.43	4.33	1,077,500
July,	74	6.12	0.83	.51	0.32	16.32	4.58	3,342,000
August,	74	5.68	0.69	.32	0.37	9.99	3.85	2,093,000
September,	70	5.63	0.80	.34	0.46	13.92	4.35	3,477,000
October,	65	6.30	1.15	.52	0.63	21.06	5.53	4,887,000
November,	52	5.20	1.18	.41	0.77	8.13	6.40	4,680,000
December,	39	4.65	0.98	.54	0.44	8.81	8.15	4,160,000
Average,	55	4.99	0.98	.37	0.61	10.55	5.72	2,993,400

Effluent of Septic Tank A.

[Parts per 100,000.]

1900.	Temperature. Deg. F.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. In Solution.	Albuminoid Ammonia. In Suspension.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	46	4.34	.51	.36	.15	7.52	4.15	1,584,000
February,	43	2.74	.28	.26	.02	4.85	3.73	1,133,000
March,	43	2.66	.28	.22	.06	4.84	1.78	813,000
April,	47	4.75	.47	.32	.15	8.96	3.37	1,490,000
May,	55	4.72	.36	.25	.11	8.16	2.54	754,900
June,	66	4.38	.41	.21	.20	11.50	2.05	399,500
July,	73	5.34	.25	.13	.12	12.06	2.42	615,000
August,	72	5.12	.32	.15	.17	12.54	2.14	1,006,000
September,	68	5.25	.33	.19	.14	11.86	2.08	938,000
October,	61	5.00	.35	.22	.13	11.08	2.44	1,417,000
November,	52	5.70	.45	.28	.17	16.30	2.99	1,793,000
December,	47	5.30	.66	.42	.24	9.51	4.52	2,570,000
Average,	56	4.61	.39	.25	.14	9.93	2.85	1,209,500

Measurements of Gas evolved from Septic Tank A upon Different Days and at Different Seasons of the Year.

Petcocks upon the top of each compartment of this tank allow the escape of gas, but at times during the year these petcocks have been closed, and the gas given off from the sewage and accumulating in the tank has been measured by closing the outlet, opening the petcocks and noting the volume of sewage required to displace the gas. The pressure exerted by the sewage in the feed tank and the temperature of the septic sewage were carefully noted also, and the volumes of gas were calculated to 60° F., with a pressure of 29.9 inches of mercury. These measurements resulted as follows, each covering a period of twenty-four hours, except in a few instances when the period was forty-eight hours: —

	Temperature. Deg. F.		Gallons of Gas per Each 100 Gallons of Sewage passing through Tank.
	Air.	Sewage.	
10 measurements, between April 21 and May 1 inclusive,	54	51	4.6
14 measurements, between May 2 and May 22 inclusive,	55	52	6.3
22 measurements, between July 10 and July 20 inclusive,	80	74	8.4

During the third period measurements were made covering two periods in each twenty-four hours, from eight A.M. to four P.M. and from this hour to eight A.M. Measuring in this way it was found that during the night, when the flow of sewage was less under control and a smaller volume per hour passing through than in the daytime, the volume of gas evolved equalled 13 gallons per each 100 gallons of sewage, compared with 5.5 gallons per 100 gallons of sewage during the period from eight A.M. to four P.M. During October a few similar measurements were made, covering a period of twenty-four hours, and resulted as follows: —

Temperature. Deg. F.		Gallons of Gas per Each 100 Gallons of Sewage passing through Tank.
Air.	Sewage.	
65	65	4.5

Measurements at this time covering different periods of the day showed the same comparative results as during July.

Septic Tank B, receiving Concentrated Sewage or Sludge.

In September, 1899, a septic tank was put into operation to receive the sludge from settled sewage, the idea being that, in places where the volume of sewage was very large and the expense of septic tanks for the treatment of the entire volume prohibitive, the sludge collected at the bottom of ordinary settling tanks could be flushed into a comparatively small septic tank and there very largely destroyed by the anærobic bacteria. The method is, of course, applicable, however, to small sewage disposal systems. As first operated, the strong settled sewage was passed into the tank at such a rate that it was fifteen days in passing through, but this was soon changed so that it was five days in passing through, and from April 18, 1900, until the end of the year, forty-nine hours in passing through the tank. In operating this tank, however, the sewage is not moving through continuously, the effluent passing from the tank only during the short time each day that concentrated sewage is being passed into it.

During the first winter of its operation there was a constant accumulation of sediment within the tank, until at the middle of May, 1900, more than 60 per cent. of the tank was filled with a very dense sludge. Sewage of as strong a character was applied during the summer as during the previous seasons, but the accumulated organic matter rapidly decreased, until at the end of the year the sediment occupied only about 8 per cent. of the tank capacity. It is probable that the right conditions for the desired bacterial actions within the tank did not occur until the summer of 1900, as there has been no further accumulation of sludge during the winter of 1900–1901, and it is believed at the present time that the accumulation taking place at first was due to the long period that the sewage remained in the tank at that time, — namely, fifteen and then five days, — and the consequent diminution of bacterial growth on account of the production of toxins. The small number of bacteria in the effluent of the tank during the first six months of the year, compared with the large number during the last six months, is especially noticeable, and strengthens this belief.

The analyses of the sewage entering and the effluent from this tank are given on the following tables, showing that 78 per cent. of the organic matter as shown by the albuminoid ammonia determinations, and 71 per cent. as shown by the oxygen consumed, was changed during the year by the action in the tank : —

Sewage as it enters Septic Tank B.

[Parts per 100,000.]

1900.	Temperature. Deg. F.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Total.	In Solution.	In Suspension.			
January,	45	4.33	2.15	.41	1.74	8.47	16.53	3,755,000
February,	51	2.60	1.64	.24	1.40	4.39	15.27	6,100,000
March,	44	1.86	1.47	.13	1.34	3.96	8.71	3,318,000
April,	46	4.23	1.21	.33	0.88	8.41	6.43	6,340,000
May,	55	5.06	1.79	.39	1.40	7.83	8.03	6,720,000
June,	71	4.27	3.85	.30	3.55	14.48	18.73	10,580,000
July,	73	4.95	3.37	.23	3.14	14.55	16.93	7,773,000
August,	72	5.06	1.17	.23	0.94	13.07	7.56	3,973,000
September,	63	5.60	2.93	.21	2.72	15.18	13.40	12,533,000
October,	59	4.00	5.66	.33	5.33	9.70	18.80	6,750,000
November,	56	5.25	2.20	.40	1.80	14.89	11.30	8,905,000
December,	46	6.00	2.78	.31	2.47	9.95	14.60	20,500,000
Average,	57	4.43	2.52	.29	2.23	10.41	13.02	8,104,000

Effluent of Septic Tank B.

[Parts per 100,000.]

1900.	Temperature. Deg. F.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Total.	In Solution.	In Suspension.			
January,	45	4.65	.39	.36	.03	8.05	2.90	213,000
February,	41	4.25	.39	.32	.07	7.62	2.78	173,000
March,	44	1.50	.17	.12	.05	3.03	1.17	600,000
April,	49	4.34	.42	.27	.15	7.62	2.81	321,000
May,	53	3.76	.36	.30	.06	8.00	3.42	750,600
June,	68	7.03	.61	.35	.26	11.31	4.33	516,500
July,	72	8.28	.51	.29	.22	12.35	4.12	1,223,000
August,	72	8.53	.60	.26	.34	11.94	4.48	1,455,000
September,	64	6.90	.71	.28	.43	12.97	4.67	1,347,000
October,	57	6.40	.74	.22	.52	11.41	4.40	2,210,000
November,	56	7.20	.75	.24	.51	12.45	4.30	2,040,000
December,	44	8.00	1.00	.28	.72	9.85	6.80	3,340,000
Average,	55	5.90	.55	.27	.28	9.72	3.85	1,182,400

The following tables show the total solids in the sewage entering and the effluent from this tank: —

Average Solids in Sewage entering Septic Tank B.

[Parts per 100,000.]

1900.	Unfiltered.			Filtered.		
	Total.	Loss.	Fixed.	Total.	Loss.	Fixed.
May,	123.0	88.1	34.9	46.2	21.5	24.7
June,	311.3	196.6	114.7	64.8	41.2	23.6
July,	310.9	211.1	99.8	73.2	39.1	34.1
August,	126.2	67.3	58.9	67.7	27.5	40.2
September,	208.2	121.8	86.4	64.1	27.0	37.1
October,	236.2	158.3	77.9	75.7	33.7	42.0
November,	150.2	92.4	57.8	57.0	19.8	37.2
December,	167.0	109.6	57.4	53.4	17.4	36.0
Average,	204.1	130.7	73.4	62.8	28.4	34.4

Average Solids in Septic Sewage B.

1900.	Unfiltered.			Filtered.		
	Total.	Loss.	Fixed.	Total.	Loss.	Fixed.
May,	57.1	27.7	29.4	56.3	33.2	23.1
June,	85.8	56.1	29.7	63.6	41.5	22.1
July,	90.7	52.4	38.3	66.7	29.6	37.1
August,	72.7	38.6	34.1	56.6	24.2	32.4
September,	81.3	34.9	46.4	57.3	17.5	39.8
October,	92.3	37.9	54.4	53.3	12.4	40.9
November,	73.3	31.0	42.3	52.5	16.5	36.0
December,	89.0	41.6	47.4	48.2	16.8	31.4
Average,	80.3	40.0	40.3	56.8	24.0	32.8

At the end of the year the sewage and sludge in both compartments were thoroughly mixed and samples taken for analysis with the following results: —

Analyses of Sewage and Sludge from Septic Tank B.

[Parts per 100,000.]

	Inlet Compartment.	Outlet Compartment.
Total solids,	1,745.00	3,520.00
Loss on ignition,	943.00	1,767.00
Fixed,	802.00	1,753.00
Solids in solution,	55.00	58.00
Loss on ignition,	20.60	22.20
Fixed,	34.40	35.80
Free ammonia,	10.50	11.80
Albuminoid ammonia, total,	22.20	53.00
Albuminoid ammonia, in solution,	.33	.60
Organic nitrogen by Kjeldahl,	29.40	94.30
Oxygen consumed, total,	156.00	256.00
Oxygen consumed, in solution,	2.44	2.32
Chlorine,	10.09	10.12
Fats,	157.20	542.00

Studying the table of total solids of the sewage entering and the effluent from this tank, we find that the average for the year of the sewage entering was 204.1 parts, and of the septic sewage flowing from the tank 80.3 parts, the difference being 123.8 parts. The tank up to Jan. 1, 1901, had sewage enter it upon approximately three hundred and sixty days, and, judging from our analyses and knowing accurately the volume of sewage that passed through the tank during this period, the total solids of the sewage in the tank at the end of the period would have been approximately 45,000 parts per 100,000 instead of 2,633 parts as they proved to be, except for the bacterial action in the tank. This difference shows clearly the very large amount of organic matter that had passed into solution or escaped as gas, and there was an apparent disappearance of some mineral matter. The tank was operated as a closed tank until July 1, 1900, and after that it had pipe openings upon the top. There was a much greater amount of free ammonia found in the effluent of the tank after these outlets were made, but this may have been due rather to the warm weather than to the fact of the open outlets. It is probable, however, that these open outlets allowed the escape of certain gases that, when held in solution in a closed tank, are inimical to the continuation of bacterial life. It will be noticed from the table on page 375 that the numbers of bacteria in the effluent more than doubled immediately after this change and increased in number throughout the remainder of the year. Discussion of the filtration of the effluent of this tank is given beyond.

Experimental Septic Tank of the Board at Andover.

An experimental septic tank of about 9,000 gallons capacity was put in operation at Andover during July, 1899, and has been continued in operation up to the present time, the following tables showing the average analyses of the sewage entering and flowing from this tank. From Jan. 1, 1900, until May 8, 1900, such volume of sewage was applied to this tank that it was about fourteen hours in passing through. From this date until July 9 such volume was applied that it was nearly four days in passing through the tank, but from July 9 throughout the remainder of the year the time of passage has varied from fourteen to eighteen hours. Operating at these rates the effluent of the tank has contained 43 per cent. as much organic matter as the sewage entering, as shown by albuminoid ammonia determinations, and 66 per cent. as shown by the oxygen consumed; that is, a removal of 57 and 33 per cent. respectively. Measurements made in May showed that 10 per cent. of the tank was filled with sediment, and on the surface of the sewage in the inlet compartment there were 3½ inches in depth of scum, but none in the other compartments.

Monthly Averages of Analyses of Andover Sewage.

[Parts per 100,000.]

1900.	Temperature. Deg. F.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Total.	In Solution.	In Suspension.			
January,	40	6.06	1.05	.72	0.33	7.98	7.38	3,494,000
February,	38	7.00	1.21	.73	0.48	10.49	9.10	4,475,000
March,	38	3.80	0.64	.52	0.12	6.23	5.20	2,260,000
April,	43	5.47	1.40	.81	0.59	11.43	8.67	9,963,000
May,	52	4.27	0.60	.35	0.25	6.28	4.13	5,150,000
June,	56	5.55	0.80	.61	0.19	8.99	6.05	4,890,000
July,	64	6.80	0.84	.61	0.23	13.32	5.35	4,235,000
August,	66	7.40	0.84	.50	0.34	7.78	5.92	3,153,000
September,	65	9.35	1.15	.81	0.34	11.23	5.85	1,100,000
October,	62	8.80	2.04	.69	1.35	7.77	7.43	4,253,000
November,	53	8.70	1.40	.83	0.57	8.75	8.10	3,850,000
December,	48	6.43	1.98	.65	1.33	7.36	6.51	4,277,000
Average,	52	6.64	1.16	.65	0.51	8.97	6.64	4,258,000

Monthly Averages of Analyses of Sewage from the Experimental Septic Tank in Andover, Mass.

[Parts per 100,000.]

1900.	Temperature. Deg. F.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. In Solution.	Albuminoid Ammonia. In Suspension.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	41	8.64	1.12	.81	.31	10.57	7.12	4,968,000
February,	38	5.80	0.62	.45	.17	5.66	3.63	220,300
March,	38	4.15	0.48	.36	.12	6.69	4.22	1,945,000
April,	44	5.40	0.67	.52	.15	8.48	4.03	2,880,000
May,	51	5.30	0.42	.30	.12	6.62	3.07	1,820,000
June,	57	7.50	0.49	.37	.12	11.45	3.80	515,000
July,	63	7.35	0.70	.44	.26	13.82	4.90	1,710,000
August,	66	6.80	0.86	.40	.46	13.47	5.88	1,737,000
September,	66	8.50	0.62	.50	.12	11.46	4.05	1,080,000
October,	62	9.93	0.83	.46	.37	11.73	4.94	2,653,000
November,	55	6.80	0.67	.43	.24	8.75	4.15	1,275,000
December,	48	4.43	0.43	.27	.16	7.24	2.51	2,340,000
Average,	52	6.72	0.66	.44	.22	9.66	4.36	1,929,000

Filtration of Septic Sewage.

In the report of last year a discussion was given upon the purification of septic sewage by filtration through intermittent sand and coke contact filters, together with a number of tables of analyses of the effluents of filters to which this sewage had been applied. Experiments upon the filtration of septic sewage in 1899 were made with the effluents from the two tanks known as Septic Tank A at the experiment station and the Andover experimental tank. The different results obtained when treating these two differing septic sewages were stated, and a brief discussion given of the reason for the poor results obtained when attempting purification of the Andover septic sewage. In this discussion it was stated that the results seemed to show that the prolongation of anærobic action was probably the cause of the unsuccessful efforts to purify satisfactorily the effluent from the Andover tank.

Further study of the purification of septic sewage has been carried on during 1900. During this year, besides the effluents from the two tanks already mentioned, we have experimented with the effluent from Septic Tank B and with sewage held in receptacles from seven to fourteen days.

Filtration of the Effluent from Septic Tank A.

During the year the four filters receiving sewage from Septic Tank A, and described in previous reports, have been kept in operation,

namely, Filters Nos. 100, 103, 116 and 118. Tables showing the analyses of the effluents of these filters and the rate at which they were operated are given beyond. Filters Nos. 100 and 118 are intermittent sand filters and contain 5 feet in depth of sand of an effective size of 0.23 millimeter, Filter No. 116 is also an intermittent filter and contains 5 feet in depth of sand of an effective size of 0.17 millimeter, and Filter No. 103 contains 5 feet in depth of small pieces of coke of such a size that all will pass through a sieve with a ½-inch mesh, 80 per cent. through a sieve with a ¼-inch mesh, and practically none through a sieve with an ⅛-inch mesh. The first three filters, namely, Nos. 100, 116 and 118, are, as stated, intermittent sand filters, while the coke Filter No. 103 is a contact filter. Each of them is $\frac{1}{20000}$ of an acre in area.

It will be noticed that, as in previous years, no difficulty was experienced in purifying at a high rate the effluent of Septic Tank A by these filters and, as previously, the effluent of Filter No. 118, to which the sewage is applied after aeration, was of a better character than the effluent of Filter No. 100, its duplicate, which has the septic sewage passed directly to its surface. It is also noticeable that, as in previous years, the effluent of Filter No. 103 was of nearly as satisfactory a character as the effluent from the coarse sand Filter No. 100, although its rate of operation was about two and one-half times as great.

Effluent of Filter No. 100.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance.		Free Ammonia.	Albuminoid.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
Jan., .	244,400	46	47	1h. 30m.	Slight.	.40	.5700	.0770	-	-	6.62	3.52	.0026	0.81	11,650
Feb., .	183,300	43	41	5h. 25m.	Slight.	.41	.6367	.1253	.1027	.0226	4.75	1.80	.0027	1.22	227,200
Mar., .	300,000	43	39	11m.	Decided.	.42	.2500	.0700	.0560	.0140	4.09	1.81	.0024	0.60	29,500
Apr., .	252,000	47	47	22m.	Decided.	.43	.4600	.0860	.0780	.0080	6.96	2.38	.0016	0.64	19,900
May, .	300,000	55	58	10m.	Decided.	.22	.5733	.0667	.0473	.0194	8.46	3.21	.0024	0.58	27,500
June,	300,000	66	64	10m.	Slight.	.17	.9200	.0640	.0400	.0240	9.40	3.08	.0016	0.72	31,400
July, .	300,000	73	74	6m.	Slight.	.24	.7700	.0640	.0370	.0270	11.73	3.23	.0009	0.76	25,800
Aug.,	288,900	72	70	5m.	Slight.	.49	.4950	.0780	.0480	.0300	13.11	3.76	.0048	0.59	34,600
Sept.,	300,000	68	63	5m.	Slight.	.23	.2500	.0520	.0340	.0180	11.09	3.43	.0012	0.46	27,300
Oct., .	300,000	61	55	8m.	V. slight.	.30	.1932	.0476	-	-	9.31	3.17	.0016	0.54	34,000
Nov., .	253,800	52	54	15m.	V. slight.	.35	.7010	.0660	-	-	11.72	3.96	.0050	0.45	454,000
Dec., .	150,000	47	45	20m.	V. slight.	.45	.3980	.0800	-	-	7.51	4.57	.0080	0.70	24,400
Av.,	264,300	56	55	-	-	.34	.5181	.0731	.0554	.0177	8.73	3.16	.0029	0.67	73,900

Effluent of Filter No. 116.

[Parts per 100,000.]

1900.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	231,100	46	49	37m.	V. slight.	.28	0.1854	.0354	6.72	3.42	.0115	.42	141
February, .	245,800	43	45	52m.	V. slight.	.15	0.0405	.0230	5.25	2.34	.0046	.28	51
March, .	266,700	43	42	47m.	V. slight.	.14	0.0176	.0206	4.62	2.24	.0032	.24	87
April, . .	276,000	47	50	42m.	V. slight.	.18	0.0644	.0264	6.68	2.67	.0075	.26	143
May, . .	192,600	55	57	12h. 25m.	Slight.	.17	0.0738	.0300	8.49	3.59	.0111	.33	246
June, . .	92,300	66	70	9m.	V. slight.	.52	1.2600	.1000	9.52	4.47	.0160	.90	-
July, . .	200,000	73	75	17m.	None.	.16	0.1080	.0215	11.82	3.87	.0016	.34	887
August, .	300,000	72	73	1h. 8m.	V. slight.	.18	0.0620	.0268	11.45	2.86	.0006	.35	3,760
September,	288,500	68	62	50m.	V. slight.	.18	0.1626	.0310	13.45	3.08	.0008	.35	2,400
October, .	300,000	61	62	37m.	None.	.22	0.1336	.0308	10.75	3.26	.0006	.38	1,704
November, .	265,400	52	59	50m.	V. slight.	.25	0.2540	.0408	11.50	3.34	.0006	.42	2,645
December, .	150,000	47	50	55m.	V. slight.	.29	1.0025	.0810	7.89	4.31	.0120	.35	860
Average,	234,000	56	58	-	-	.23	0.3637	.0389	9.01	3.29	.0058	.39	1,175

Effluent of Filter No. 118.

[Parts per 100,000.]

1900.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	229,600	46	44	1h. 50m.	Slight.	.34	1.5600	.0550	6.45	3.48	.0280	.61	2,950
February, .	191,700	43	39	1h. 15m.	V. slight.	.39	0.2651	.0496	4.94	1.90	.0028	.73	57,600
March, .	263,000	43	37	1h. 48m.	V. slight.	.15	0.0144	.0302	4.37	2.06	.0004	.28	5,100
April, . .	252,000	47	44	9m.	Decided.	.19	0.2300	.0280	6.94	0.99	.0010	.39	14,400
May, . .	300,000	55	58	18m.	V. slight.	.26	0.2306	.0673	8.75	2.64	.0007	.81	9,861
June, . .	300,000	66	65	12m.	None.	.26	0.3600	.0280	8.93	3.27	.0004	.43	1,400
July, . .	300,000	73	75	10m.	None.	.18	0.2623	.0300	10.87	3.94	.0004	.40	4,100
August, .	288,900	72	75	14m.	None.	.12	0.0631	.0246	13.61	3.75	.0006	.31	3,350
September,	300,000	68	62	10m.	None.	.17	0.0806	.0246	12.90	3.19	.0005	.30	8,300
October, .	300,000	61	59	5m.	None.	.13	0.1220	.0232	10.02	2.99	.0002	.42	1,600
November,	253,800	52	58	10m.	None.	.20	0.2580	.0336	11.70	3.96	.0004	.35	4,800
December, .	142,300	47	46	18m.	V. slight.	.35	0.8185	.0670	7.56	3.96	.0012	.51	7,400
Average,	260,100	56	55	-	-	.23	0.3554	.0384	8.92	3.01	.0031	.46	10,072

Effluent of Filter No. 103.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
January, .	570,400	46	49	Decided.	.47	0.4300	.1010	-	-	6.05	2.39	.0055	.87	152,000
February, .	466,700	43	45	Decided.	.33	0.1350	.0540	-	-	5.11	1.74	.0050	.57	43,700
March, .	700,000	43	41	Slight.	.27	0.0860	.0460	-	-	4.22	1.67	.0004	.41	41,600
April, .	588,000	47	49	Decided.	.47	0.2720	.0780	.0720	.0060	6.94	1.22	.0068	.60	91,400
May, . .	700,000	55	59	Decided.	.36	0.4487	.0793	.0653	.0140	8.52	3.20	.0048	.56	180,400
June, .	700,000	66	66	Slight.	.28	0.5300	.0600	.0500	.0100	9.02	2.77	.0040	.72	72,600
July, . .	700,000	73	76	V. slight.	.37	0.9367	.0713	.0473	.0240	11.50	3.42	.0035	.51	35,800
August, .	674,100	72	70	V. slight.	.40	0.2900	.0550	.0500	.0050	13.72	2.57	.0074	.51	29,200
September,	700,000	68	63	V. slight.	.35	0.2600	.0480	.0440	.0040	11.40	2.90	.0040	.53	25,300
October, .	700,000	61	56	Slight.	.44	0.2680	.0710	-	-	9.48	3.29	.0080	.55	135,600
November,	600,000	52	54	Slight.	.43	0.4300	.1020	.0840	.0180	12.54	3.52	.0036	.71	163,500
December,	350,000	47	47	Slight.	.65	1.0800	.1060	.0840	.0220	7.73	3.29	.0500	.96	163,200
Average,	620,800	56	56	-	.40	0.4305	.0726	.0621	.0105	8.85	2.67	.0086	.63	94,500

Filtration of the Effluent of Septic Tank B.

As stated on page 374, the sewage entering this tank is very strong, and it has been during a large part of the year two days in passing through the tank. Moreover, the sewage does not pass continuously through the tank, but the effluent flows from the outlet only during the short period each day when the sewage is entering. As the effluent of this tank approximated in age the effluent of the Andover septic tank, experiments were begun in June upon the purification of this effluent by filtration. In the first place, a sand filter, — Filter No. 145, — containing 4 feet in depth of sand of an effective size of 0.24 millimeter, was put into operation at the rate of 100,000 gallons per acre daily. It was expected that, if long-continued anærobic action upon the Andover sewage and the formation of ptomaines, etc., were the cause of the poor results obtained when attempting to filter this sewage, the effluent of Septic Tank B, in which the anærobic actions had proceeded to nearly the same point as in the Andover septic tank, would also be of such a charac-

ter that, when applied to filters, nitrification would be impeded. The effluent obtained, however, has not been of so poor a quality as those from the Andover filters. In fact, nitrification has been very active within the sand filter, and the nitrates in its effluent have averaged 3.64 parts per 100,000. It is noticeable, however, that during a considerable portion of the year the free and albuminoid ammonia in the effluent have both been high, the bacterial removal by the filter poor, and the effluent has had considerable turbidity and odor.

A contact filter, — No. 154, — containing 4 feet in depth of coke breeze, was started in September. This filter has been operated at an average rate of 570,000 gallons per acre daily, a rate very similar to that maintained by Filter No. 103 (see page 382), receiving the effluent from Septic Tank A, taking into consideration that Filter No. 154 is 1 foot shallower. Septic Sewage B has been applied to this filter in the same manner that Septic Sewage A has been applied to Filter No. 103, but nitrification has been very inactive in the filter and the effluent poorly purified, containing a very large amount of albuminoid ammonia and an average of over 5 parts free ammonia during its period of operation. Tables showing the average analyses of the effluents of these two filters follow: —

Effluent of Filter No. 145.

[Parts per 100,000.]

1900.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
June, .	100,000	68	79	-	V. slight.	.22	1.6000	.0240	.0200	.0040	9.89	0.012	.0066	.34	178,900
July, .	100,000	72	75	-	V. slight.	.21	1.9800	.0300	-	-	11.51	3.818	.2833	.49	107,400
Aug., .	92,600	72	74	-	None.	.04	0.0800	.0270	-	-	9.91	2.950	.0024	.26	11,700
Sept., .	176,000	64	67	25m.	V. slight.	.29	0.4764	.0798	-	-	12.28	5.298	.0022	.54	22,965
Oct., .	200,000	57	61	1h. 48m.	Slight.	.28	0.4917	.0878	.0760	.0118	12.46	4.150	.0014	.55	57,300
Nov., .	176,900	56	57	2h. 31m.	Slight.	.27	0.5520	.0850	-	-	10.75	5.150	.0067	.53	125,700
Dec., .	100,000	44	44	52m.	Slight.	.45	0.3115	.1060	-	-	9.33	4.140	.0008	.59	245,000
Av.,	135,000	62	65	-	-	.25	0.7845	.0628	-	-	10.88	3.645	.0433	.47	106,800

Surface raked 3 inches deep once each week. December 3 to December 17, experiment interrupted by break in sewer pipe.

Effluent of Filter No. 154.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature Deg. F. Sewage.	Temperature Deg. F. Effluent.	Appearance. Turbidity.	Appearance. Color.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. In Solution.	Albuminoid Ammonia. In Suspension.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
September,	731,300	64	62	Decided.	0.45	6.30	.2680	.1080	.1600	11.05	.01	.0000	1.38	-
October, .	666,000	57	66	Decided.	0.64	5.00	.2887	.1087	.1800	11.89	.86	.0760	1.33	163,700
November,	589,000	56	52	Decided.	1.85	5.00	.2480	.1310	.1170	11.22	.25	.0176	1.39	343,300
December,	290,300	44	-	Decided.	1.10	4.20	.2840	.2000	.0840	9.49	.07	.0000	1.84	563,000
Average,	569,200	55	60	-	1.01	5.13	.2722	.1369	.1353	10.91	.30	.0234	1.49	356,700

September 11 to September 16, sewage applied in four doses of 1 gallon each, one hour apart; filter stood two hours and then drained slowly. September 17 to December 31, sewage applied in three doses of 1 gallon each, one hour apart; filter stood two hours and then drained slowly. Surface raked 3 inches deep December 27.

Filtration of Andover Septic Sewage.

The intermittent sand filter, $\frac{1}{200}$ of an acre in area and containing 5 feet in depth of sand of an effective size of 0.23 millimeter, has been kept in operation at rates varying from 50,000 to 220,000 gallons per acre daily, with the results shown in the table of analyses beyond. There was considerable nitrification within the filter during a portion of the year, but poorer results were obtained than we would expect if treating a fresher sewage, containing an amount of organic matter equal to that in the sewage from this septic tank.

The coke contact filter, $\frac{1}{200}$ of an acre in area and 5 feet in depth, has been kept in operation at rates varying from 100,000 to 2,000,000 gallons per acre daily. During a considerable portion of the winter it was operated as a continuous filter, that is to say, a stream of sewage was passing through it continuously during a large part of the twenty-four hours, at the rate of 2,000,000 gallons per acre per day, this stream being fairly well distributed over the surface of the filter, and the surface not intentionally covered with sewage during any portion of the day. During this period there was no nitrification, the effluent did not contain dissolved oxygen and it was very ill smelling. Beginning May 8 it was operated for a few days as contact filters are usually operated at Lawrence, — that is, the outlet closed and the filter filled in four applications of sewage

one hour apart, allowed to stand full two hours and then drained slowly, — the rate for a few days at this time being 600,000 gallons per acre daily, but without any better results than previously obtained. The rate was then reduced to 100,000 gallons per acre daily and the filter operated as an intermittent filter, sewage being applied very slowly during a period of one hour, this method being followed for twelve days, at the end of which time the rate was increased to 200,000 gallons per acre daily, and two weeks later to 400,000 gallons per acre daily. This was in the warm weather of the last of May and the first of June, but even at these low rates, that is, for a filter as coarse as this, nitrification did not occur and the effluent of the filter did not contain dissolved oxygen.

Beginning August 21 and continuing throughout the remainder of the year it was again operated as a contact filter, at the rate of 600,000 gallons per acre daily, and at this time a small amount of sand was mixed with the coke in the filter, to see if by any means this would furnish conditions favorable to nitrification, but this also failed. The only time during the year when nitrates were found in the effluent was in the month of November, when the sewage, owing to high rains, contained less organic matter than usual, and reached the filtration area more promptly than usual. A second coke contact filter was put into operation here during the last three or four months of the year, containing coke of a different character, but with no better results than obtained with the larger filter.

Effluent of the Andover Experimental Sand Filter.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, . .	220,000	40	35	Decided.	1.58	8.86	.3980	12.49	0.03	.0012	2.72	376,000
February, . .	220,000	38	36	Decided.	2.22	6.35	.3050	7.56	0.02	.0006	1.99	107,300
March, . . .	220,000	38	37	Decided.	2.38	4.60	.1360	6.54	0.01	.0006	1.90	144,800
April, . . .	195,000	43	46	Great.	1.37	5.77	.1653	8.55	0.01	.0001	2.07	82,700
May, . . .	135,000	52	55	Decided.	3.02	7.05	.3100	7.00	0.02	.0000	2.29	238,800
June, . . .	195,000	56	63	Decided.	0.95	6.50	.2400	10.08	0.01	.0001	1.65	18,000
July, . . .	195,000	64	72	Slight.	2.50	8.07	.2600	13.70	0.95	.0050	1.84	194,000
August, . . .	195,000	66	71	V. slight.	0.38	2.56	.1093	13.98	1.71	.0075	0.80	43,800
September, . .	150,000	65	67	V. slight.	0.69	0.93	.1140	11.04	0.75	.0300	0.81	89,000
October, . .	150,000	62	62	Decided.	3.72	2.80	.2000	12.03	0.15	.0075	1.59	99,700
November, . .	100,000	53	50	Slight.	0.63	2.86	.1750	10.87	1.51	.0152	0.91	59,800
December, . .	50,000	48	41	None.	0.33	1.11	.0700	8.05	1.42	.0087	0.44	12,600
Average, .	169,000	52	53	-	1.65	4.79	.2069	10.16	0.55	.0064	1.58	122,200

Effluent of the Andover Experimental Coke Contact Filter.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
January,	2,250,000	41	41	Great.	0.57	8.72	.98	.70	.28	10.74	.02	.0001	5.40	4,342,000
February,	2,000,000	38	38	Great.	0.65	5.65	.57	.44	.13	7.46	.02	.0004	3.37	194,500
March,	2,000,000	38	38	Decided.	0.46	4.30	.34	.30	.04	6.98	.01	.0000	2.98	1,410,000
April,	2,000,000	44	44	Decided.	0.70	5.30	.49	.42	.07	8.22	.03	.0005	3.00	2,043,000
May,	500,000	51	53	Decided.	0.61	6.00	.38	.34	.04	6.87	.11	.0050	2.20	1,051,000
June,	400,000	57	60	Decided.	1.40	7.50	.47	.38	.09	10.87	.04	.0002	3.35	490,000
July,	400,000	63	70	Decided.	1.38	8.20	.73	.50	.23	13.81	.03	.0000	4.60	2,205,000
August,	600,000	66	70	Decided.	0.39	5.40	.51	.34	.17	12.01	.03	.0000	2.52	866,000
September,	600,000	66	67	Decided.	0.72	5.85	.38	.26	.12	10.96	.01	.0000	3.09	1,520,000
October,	600,000	62	64	Decided.	1.45	8.37	.50	.40	.10	12.00	.01	.0000	2.99	1,071,000
November,	600,000	55	55	Decided.	0.80	6.45	.44	.36	.08	9.90	.04	.0004	2.77	855,000
December,	600,000	48	47	Slight.	0.58	2.73	.21	.17	.04	7.72	.19	.0031	1.17	686,000
Average,	1,046,000	52	54	-	0.81	6.21	.50	.38	.12	9.80	.05	.0008	3.12	1,394,500

Effluent of the Small Experimental Coke Contact Filter at Andover.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
September,	650,000	66	68	Decided.	0.55	6.30	.42	.37	.05	9.36	.02	.0000	2.32	-
October,	650,000	62	60	Decided.	1.03	8.97	.54	.28	.26	12.23	.01	.0000	2.23	452,800
November,	650,000	55	47	Decided.	0.70	7.55	.56	.40	.16	10.37	.02	.0000	2.84	620,000
December,	650,000	48	38	Slight.	0.64	4.00	.26	.18	.08	8.00	.09	.0030	1.55	385,800
Average,	650,000	58	53	-	0.73	6.71	.45	.31	.14	9.99	.04	.0008	2.24	486,200

Purification of Sewage Seven and Fourteen Days Old.

A further experiment upon the purification of sewage which had undergone long-continued anærobic action was made by holding sewage in gallon bottles for at first seven and later fourteen days,

before applying it to a small tube filter containing 27 inches in depth of sand of an effective size of 0.25 millimeter — Filter No. 152 — at a rate of 100,000 gallons per acre daily. This sewage was easily purified to a considerable degree, and nitrification was active within the filter during its period of operation, but the free ammonia was always high in the effluent, as shown by the following table of analyses: —

Effluent of Filter No. 152.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
August,	100,000	73	70	V. slight.	0.24	.7493	.0405	6.12	1.02	.8500	1.28	10,583
September,	100,000	68	66	V. slight.	0.30	.3760	.0365	12.09	4.19	.0113	0.37	283,400
October,	100,000	65	62	None.	0.25	.1400	.0280	10.88	5.09	.0048	0.25	1,800
November,	100,000	52	49	V. slight.	0.16	.2307	.0440	8.43	4.13	.0013	0.31	30,200
December,	46,200	45	45	Slight.	1.35	.6803	.2155	8.31	2.58	.0024	1.02	130,500
Average,	89,200	61	58	–	0.46	.4353	.0729	9.17	3.40	.1740	0.65	91,300

Discussion of Septic Sewage and its Purification in Connection with the Cause of Different Results obtained when treating Effluents of Different Septic Tanks.

It is noticeable in the first place that, as in previous years, the septic sewage from Tank A was easily purified by both intermittent sand and coke contact filters, better purification being obtained in intermittent filters when the sewage was aerated before application. The sewage from Septic Tank B was purified fairly well by an intermittent sand filter, but only slightly by a coke contact filter that would certainly have produced excellent results if sewage from Septic Tank A had been applied to it. Andover septic sewage was purified to a considerable degree when it was applied to an intermittent sand filter, and nitrification was fairly active at times, but we were unable to purify it in either of two coke contact filters to any appreciable extent, or to start nitrification within these filters except slightly for a short period towards the end of the year. The sewage held in receptacles from seven to fourteen days before being applied to filters was easily purified by intermittent sand filtration and good

nitrification occurred, but we have reason to believe that it could not have been purified in contact filters, although we did not treat this sewage in contact filters during the year. This sewage, moreover, is not a true septic sewage, but simply a very old or stale sewage, that is, the desired bacterial conditions and the evolution of gas had not occurred, generally speaking, with this sewage before its application to the filter.

Studying the different results obtained with these different sewages and different filters, a number of facts already known in sewage purification aid in explaining the differing results obtained, and special analyses and experiments that we have made have been of further aid in assisting to a true comprehension of these results. It is, of course, evident that we cannot obtain nitrification within a filter unless there is an ample supply of air held within the pores of the filter in contact with the sewage, to admit of oxidation and nitrification taking place. It is a fact that frequent examinations of the effluents of the sand filters and the coke filter receiving septic sewage A prove that these effluents, when flowing from the filters, contained in almost every instance free dissolved oxygen. The effluent of the sand filter receiving septic sewage B contained generally free oxygen, but the effluent of the coke filter receiving this sewage has never contained free oxygen when analyses have been made. The effluent of the Andover sand filter has rarely contained free oxygen, and the effluents of the Andover coke filters have never contained free oxygen at times of examination. In other words, when a small volume of sewage is applied to a sand filter nitrification will take place, no matter to what degree of putrefaction this sewage has attained at the time of its application, if there is an abundance of air to come in contact with the sewage. When, however, sewage in an advanced state of putrefaction is applied to a contact filter, and the entire open space of the filter filled with this sewage, it is possible that oxidation may be so rapid that the supply of oxygen within the filter will be exhausted before the process of nitrification has had time to begin. That is to say, even if the nitrifying bacteria are in the sewage when it is passed to the filter or in the filter at the time of the introduction of the sewage, their power may be entirely overcome temporarily by a lack of oxygen.

The slow absorption of oxygen by comparatively fresh sewage, and its rapid absorption by very stale or septic sewage, is shown by the fol-

lowing experiments, made in order to throw some light upon the non-nitrification of some septic sewage in contact filters. For this purpose regular station sewage, septic sewage A, septic sewage B, Andover septic sewage and sewage thirteen days old were experimented with. The method of making these experiments was as follows: into a half-gallon bottle one-quarter filled with city water, saturated with dissolved oxygen, these sewages were siphoned in such a manner as to prevent any contact with air when entering the bottle except when reaching the liquid in the bottle, the bottles being entirely filled with the mixture of water and sewage. Samples for the determination of dissolved oxygen were then siphoned from these bottles into the small bottles in which the determinations were made, one sample being examined immediately and the rest remaining stoppered until the time of examination, as denoted in the tables. The results were as follows, the first examination in each instance being made as soon as possible after filling the bottles for analysis: —

Regular Lawrence Sewage.

Time of Examination.	Temperature of Sewage. Deg. F.	Dissolved Oxygen. Per Cent. of Saturation.	Time of Examination.	Temperature of Sewage. Deg. F.	Dissolved Oxygen. Per Cent. of Saturation.
2.30 P.M., . . .	49	20.1	5.30 P.M., . . .	49	3.7
3.30 " . . .	49	12.6	8.30 " . . .	49	0.0
4.30 " . . .	49	9.7			

Septic Sewage A.

2.30 P.M., . . .	51	9.3	4.30 P.M., . . .	51	0.0
3.30 " . . .	51	5.3	5.30 " . . .	51	0.0

Septic Sewage B, February 5.

10.45 A.M., . .	49	0.0	10.50 A.M., . .	49	0.0
10.47 " . . .	49	0.0			

Septic Sewage B, February 6.

8.45 A.M., . . .	43	5.3	9.30 A.M., . . .	43	0.8
9.00 " . . .	43	2.1	9.45 " . . .	43	0.0
9.15 " . . .	43	1.4			

Andover Septic Sewage.

Time of Examination.	Temperature of Sewage. Deg. F.	Dissolved Oxygen. Per Cent. of Saturation.	Time of Examination.	Temperature of Sewage. Deg. F.	Dissolved Oxygen. Per Cent. of Saturation.
2.10 P.M., . . .	49	12.0	4.10 P.M., . . .	49	2.5
3.10 " . . .	49	9.9	5.10 " . . .	49	0.0

Sewage Thirteen Days Old.

9.50 A.M., . . .	46	7.7	10.50 P.M., . . .	46	4.6
10.20 " . . .	46	6.4	11.50 " . . .	46	0.0

The per cent. of saturation of the dissolved oxygen of the various mixtures should have been 25 in each case at the time of the first analysis, if no change — that is, no absorption of oxygen — had taken place during the manipulation. As a matter of fact, we find that with the regular station sewage 20 per cent. of this oxygen had been absorbed or exhausted in the three or four minutes ensuing between the time of mixing and the time of analysis. With septic sewage A, 64 per cent. of the oxygen had been absorbed at the same time. With septic sewage B, in one instance the entire amount of free oxygen had been exhausted before the analysis could be made, and in the other instance, 80 per cent. had been exhausted. With the Andover septic sewage, 52 per cent. had been exhausted at the time of the first analysis, and with the sewage thirteen days old 70 per cent. The Andover septic sewage here experimented with was of a weaker character and in a state of less advanced decomposition than had occurred with this sewage at the time of its application to filters during the greater part of the year. For, as noted before, owing to high rainfalls, etc., this sewage in the month of November became considerably weaker, reached the filter area more quickly, and nitrification occurred to some slight extent in the coke filters. It is further noticeable that the oxygen was not exhausted from septic sewage A until between one and two hours after the experiment was begun. With septic sewage B, however, in one instance, as stated, the entire amount of oxygen was exhausted immediately, although in another instance more than half an hour elapsed before this entire exhaustion occurred. (Later experiments have shown immediate exhaustion.)

These results help to explain what was stated before in regard to the volume of oxygen necessary in filters for nitrification to take place. It is evident that, if sewage in the condition of septic sewage B upon the date of this first experiment flowed into a contact filter, filling it entirely, no nitrification could be expected to take place within the filter, as the oxygen with which it would come in contact would probably not be more than enough for the first rapid oxidation, this quick oxidation being probably a chemical action rather than the bacterial oxidation upon which nitrification depends. When such sewage as that from Septic Tank B is run in a comparatively small volume upon the surface of intermittent sand filters, however, it remains upon the surface in most instances long enough for considerable oxidation to take place, and it meets a large volume of air as it slowly passes through the filter and hence nitrification occurs.

As, moreover, this rapid absorption of oxygen did not cause a change in the character of the organic matter of the sewage that could be readily detected by the ordinary chemical analyses, experiments were undertaken to show whether or no it was the oxidation or saturation of gases. For this purpose a sample of septic sewage B was first sterilized by heat, this not only killing the bacteria as determined, but expelling all the gases. The sample then had water saturated with oxygen mixed with it, as previously described, and was then allowed to stand, determinations of the dissolved oxygen present being made practically once an hour for eight hours. At the beginning of the period the per cent. of saturation was 65 and at the end of the period 63, showing that sterilizing the sewage by heat had so changed it that this quick absorption of oxygen did not occur. A second volume of septic sewage B was sterilized with mercuric acetate, this, of course, killing the bacteria, as determined by tests, but not expelling the gases. This sewage was then, as usual, mixed with water saturated with dissolved oxygen, and determinations of dissolved oxygen made immediately after the admixture and once an hour for practically eight hours. Immediate examination showed that nearly all the oxygen had been rapidly absorbed. Instead of 65 per cent. of saturation, as should have occurred if the exhaustion of oxygen was due to bacterial action, there was only 3.8 per cent., and at the end of eight hours this small volume of oxygen had also disappeared. These experiments were repeated, and seemed to prove conclusively that the

rapid absorption of oxygen was by gases or by organic matter that sterilizing by heat had so changed that it was not easily oxidized rather than by bacterial action.

While this factor of oxygen, and its rapid exhaustion, makes clear one of the reasons for the difficulty of nitrifying septic sewage of a certain strength and degree of putrefaction, except at low rates upon intermittent sand filters, it does not satisfactorily explain all the results obtained when attempting purification of the Andover septic sewage. Can we not, however, satisfactorily explain these results by assuming that we have groups of bacteria of a different character in each tank, and that in Septic Tank B and the Andover tank ptomaines are produced that seriously interfere with nitrification when this sewage is applied to filters? We know that, if the production of different proportions of the gases evolved indicates different bacterial actions, the conditions obtaining in these tanks must be quite different one from another, and the organic matter in the sewage must be worked over to a different extent or by different bacteria, giving differing end products, as shown by the following gas analyses: —

Analyses of Gas from Septic Tanks.

	Gas from Septic Tank A (Per Cent.).	Gas from Septic Tank B (Per Cent.).	Gas from Andover Septic Tank (Per Cent.).
Methane,	79.0	37.5	28.7
Nitrogen,	16.0	19.0	61.0
Carbon dioxide,	3.4	42.2	9.8

The gas from Tank B and the Andover tank was collected by warming a volume of the sewage and expelling the gas.

Anærobic Filters in Place of Septic Tanks.

Anærobic Filter No. 133, $\frac{1}{20000}$ of an Acre in Area.

Studying early investigations of sewage disposal, we find records of attempts at purification by upward filtration, but with generally unsatisfactory results. These results were probably due to poorly selected filtering material or poorly constructed filters, however, together with a lack of knowledge of the essential principles of sewage purification as we understand them to-day, that is, the effluent

of upward filtration without air was expected to be of a character suitable to run to waste without causing a nuisance, instead of being, as now understood, only in a suitable condition for purification by means of filtration in contact with air.

Beginning in 1899 and continuing throughout 1900, a filter of broken stone has been operated at the station, up through which sewage has been passed in a constant stream. The idea in starting this filter was, as stated in the last report, to produce the same action as occurs in an anærobic or septic tank, but furnishing a very much greater surface for bacterial growth than is supplied in a septic tank of the usual construction, and hence with the expectation of obtaining better results. The stone in this filter is of such grade that all will pass through a sieve with one mesh to the linear inch, 24 per cent. through a sieve with a ½-inch mesh, and none through a sieve with a ¼-inch mesh.

The filter has always been kept full of sewage, and anærobic action began soon after it was started in 1899, as determined by the evolution of gas given off through petcocks in the cover of the filter. During 1900 the rate at which sewage has been passed through it has varied from 910,000 to 2,250,000 gallons per acre daily during different portions of the year; these varying rates making the time of passage of sewage through this tank filter vary from a maximum of twenty-six hours to a minimum of ten and one-half hours. Varying within these rates of flow, equally good results have been obtained as far as reduction of organic matter in the effluent compared with that in the applied sewage indicates results, but the quicker rate of passage was largely during the warm or comparatively warm weather, when bacterial action is the most active, and the same rate during the colder months might have resulted in a serious accumulation of organic matter in the lower portion of this anærobic filter. Examinations of the filtering material made at the end of the year, however, showed but a comparatively small amount of sludge or organic matter covering the stones even in the bottom portion of the filter, not enough to appreciably impede the passage of sewage up through these stones. Although the tank is filled with the stones, only 55 per cent. of the total space within this tank or filter is occupied by the broken stone, leaving 45 per cent. of open space between the stones for the flow of sewage. The average reduction of organic matter, as shown by albuminoid ammonia and oxygen consumed de-

terminations, has been 70 and 54 per cent. respectively. Comparing the average analysis of the effluent of this anærobic tank or filter with the average analyses of the effluent of Septic Tank A, we see that the percentage reduction of organic matter was greater in Filter No. 133, and that an effluent was produced containing a smaller amount of matter in suspension and hence more easily filtered at high rates.

Effluent of Filter No. 133.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
January, .	910,000	44	52	Great.	0.40	4.7000	.2450	.2300	.0150	7.26	.006	.0000	2.67	893,000
February,.	1,009,000	41	49	Decided.	0.60	3.5200	.1800	.0660	.1140	5.01	.011	.0010	1.78	260,000
March, .	1,436,100	43	52	Decided.	0.63	2.8800	.1355	.1130	.0225	4.95	.006	.0001	1.33	320,600
April, .	1,407,000	48	58	Decided.	0.75	5.2000	.2040	.1760	.0280	9.19	.006	.0000	1.96	445,000
May, . .	1,290,000	54	60	Slight.	0.75	5.6333	.2000	.1667	.0333	8.35	.020	.0000	1.94	548,800
June, .	1,348,000	70	71	Decided.	0.72	5.4000	.1720	.1280	.0440	11.22	.008	.0000	1.93	223,800
July, . .	1,645,000	75	78	Decided.	0.87	5.3667	.1653	.1173	.0480	14.36	.008	.0000	1.52	257,700
August, .	2,094,000	75	73	Decided.	0.62	4.5000	.1620	.0940	.0680	14.29	.009	.0000	1.42	293,000
September,	2,147,000	69	68	Decided.	0.56	5.5000	.1860	.0980	.0880	12.37	.005	.0000	1.48	751,300
October, .	2,251,000	61	65	Decided.	1.09	5.3000	.2390	.1390	.1000	14.40	.010	.0000	1.48	751,800
November,	2,169,000	53	54	Decided.	0.65	4.5000	.2720	.1880	.0840	8.29	.010	.0000	2.40	1,004,000
December,	1,620,000	47	49	Decided.	–	4.8000	.2720	.2640	.0080	7.14	.010	.0000	2.58	399,000
Average,	1,610,500	57	61	–	0.69	4.7750	.2027	.1483	.0544	9.74	.009	.0001	1.87	512,300

Continuous Intermittent Filter No. 134, $\frac{1}{20000}$ of an Acre in Area.

Ærobic Filter No. 134 contains 5 feet in depth of broken stone of the same grade as that in Anærobic Filter No. 133. It is operated in what we have designated as the continuous intermittent manner; that is, sewage is passed through it during most of the day in a continuous stream, but with a short period of rest daily. First put into operation in 1899, it has been continued during 1900, and has received the effluent from Filter No. 133 during the entire year, with the exception of a few days in February. As stated in the last report of the Board, a quick, vigorous and abundant growth of

Beggiatoa appeared in this filter during January, 1900, this growth filling so completely the open space between the pieces of broken stone, especially in the upper portion of the filter, that sewage could scarcely pass below the surface and nitrification ceased. The effluent of the filter did not contain dissolved oxygen, and analyses of the atmosphere from its interior showed the absence of oxygen. It was allowed to rest for a week, and then for six days the effluent of a contact filter in satisfactory operation was applied, at a rate of 200,000 gallons per acre daily, the reason being to introduce, if possible, nitrifying organisms, together with an effluent containing free oxygen. Following this treatment, the growth of *Beggiatoa* disappeared as quickly as it grew, and the effluent of Filter No. 133 was again applied, at first at the rate of 250,000 gallons per acre daily, this rate being doubled each week until a rate of approximately 1,000,000 gallons per acre daily was reached. The rate of operation has been varied very much during the year, as will be seen from the table of average analyses given beyond. Nitrification was constant after the trouble caused by *Beggiatoa*, and free oxygen was found invariably in its effluent excepting during a portion of July; the probable cause for its absence then being the great bacterial activity and rapid oxidation induced by high temperature, and the consequent exhaustion of the free oxygen in the filter before the applied sewage reached its outlet. The high nitrites in the effluent during this month are also noticeable, perhaps due to a reducing action in the lower portion of the filter, but more probably to arrested nitrification. It is noticeable also that in this filter, 5 feet in depth, the nitrates produced were largely a simple change of a portion of the free ammonia in the septic sewage applied, the albuminoid ammonia in the applied sewage being comparatively small and, although reduced 50 per cent. during the passage of the sewage through the filter, would account for only about .10 of a part of nitrate in the effluent. The results obtained in this respect with this filter 5 feet in depth, compared with those obtained with deeper filters of the same construction and operation, are discussed beyond. It is particularly noticeable that the bacteria of the applied sewage were reduced 85 per cent. during the quick passage of the sewage through this filter of coarse material.

Effluent of Filter No. 134.

[Parts per 100,000.]

1900.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
January, .	880,000	52	48	Great.	.61	3.6000	.1320	.1040	.0280	7.22	0.133	.0048	1.31	139,000
February, .	285,000	49	45	Decided.	.38	0.5000	.1020	.0800	.0220	4.99	3.680	.0210	0.70	66,500
March, .	1,015,000	52	47	Slight.	.34	0.7033	.0630	.0580	.0050	4.66	1.610	.0085	0.51	25,900
April, .	1,121,000	58	53	Slight.	.45	3.0500	.1040	.1020	.0020	8.89	1.230	.0340	0.92	68,600
May, . .	1,070,000	60	59	V. slight.	.45	2.2667	.1167	.0920	.0247	8.38	1.460	.0213	0.89	55,400
June, .	1,155,000	71	67	Slight.	.60	3.2667	.1347	.1043	.0304	10.84	1.090	.0413	1.11	82,400
July, . .	1,394,000	78	74	Slight.	.53	2.4333	.1233	.0933	.0300	13.81	1.970	.1100	0.92	56,100
August, .	1,735,000	73	73	V. slight.	.48	3.5000	.1820	.1710	.0110	14.56	1.360	.0285	1.46	21,500
September,	1,764,000	68	66	V. slight.	.38	2.2000	.0900	.0620	.0280	12.29	3.000	.0140	0.68	124,400
October, .	1,957,000	65	63	V. slight.	.75	2.9250	.1110	.0880	.0230	14.40	1.200	.0220	0.94	37,700
November,	2,046,000	54	54	Slight.	.72	2.2800	.1240	.0880	.0360	8.20	1.500	.0420	1.02	62,400
December,	1,527,000	49	48	Decided.	.64	2.4000	.1320	.1260	.0060	6.83	1.840	.0060	1.20	150,000
Average,	1,329,100	61	58	-	.53	2.4271	.1179	.0974	.0205	9.59	1.673	.0295	0.97	74,200

February 14 to February 18 and March 3 to March 6, experiment interrupted by freshet, and December 2 to December 17, by break in sewer pipe.

Continuous Intermittent Filters compared with Contact Filters. Depths of Eighteen and Twelve Feet of Filtering Material.

Filters Nos. 135 and 136, $\frac{1}{20000}$ of an Acre in Area.

These two filters were put into operation in November, 1899. As first constructed they contained 17 feet 10 inches in depth of coarse broken stone of such a grade that all would pass through a screen with a 1-inch mesh, 40 per cent. through a screen with a ½-inch mesh and 4 per cent. through a screen with a ¼-inch mesh. At the beginning of the year they were being operated at the approximate rate of 1,000,000 gallons per acre daily, and, as described in the last report, were beginning to have an effluent containing nitrates when a quick growth of *Beggiatoa* appeared, clogging both filters to such an extent that sewage could pass but very slowly through them. This clogging growth of *Beggiatoa* stopped nitrifica-

tion and prevented its again starting while the filters were in this condition. They were then both treated in the manner already described with Filter No. 134, page 396, and, further than this, air was forced through them for two hours daily from February 2 to 5 inclusive and February 24 to March 2 inclusive. This treatment prevented the further growth of *Beggiatoa*, destroyed that already grown and thus quickly removed the clogging. They were both operated as continuous intermittent filters after this trouble, as before, and at a rate of approximately 1,000,000 gallons per acre daily. Nitrification was very feeble in them, however, and analyses of air from their interiors showed generally a lack of oxygen in all but the upper portion of each filter. For example, a sample of the atmosphere from the interior of Filter No. 136, at a point about 12 feet from its surface, had the following composition: carbonic acid 6.8 per cent., nitrogen 93.2 per cent., no other gas being present. Series of samples for the determination of carbonic acid and oxygen in the air from the interior of this filter upon April 1 and May 9 are given beyond. Single determinations made upon other days are also given, these determinations showing little or no oxygen present during the period of non-nitrification, but a considerable percentage in October, during the period of active nitrification.

Upon April 16 Filter No. 135 began to be operated as a contact filter, and was filled in two applications of sewage two hours apart, Filter No. 136 being continued in operation in the continuous intermittent manner. Owing to the depth of Filter No. 135, the rate of filtration was necessarily increased by the change of operation, — that is, by filling the filter to its surface while having a closed outlet, — making it approximately 2,600,000 gallons per acre daily. At the same time the rate of continuous intermittent Filter No. 136 was decreased from time to time, until from May 14 to June 19 it was only 100,000 gallons per acre daily. The reduction of rate, however, did not start nitrification, practically no nitrates being found in its effluent at the beginning of June, and nitrification had been very feeble during the previous two months. Nitrification had been somewhat better in Filter No. 135 during the months of April and May than in Filter No. 136, notwithstanding the much greater rate of operation, the manner of filling and emptying having caused a greater change of air within the filter than the method of operating Filter No. 136, as shown by the tables of analyses of air from the

interior of this filter given beyond. The samples of air from this filter that were analyzed were taken — when the filter was being operated as a contact filter — at different times after draining the sewage from the filter, while the samples from Filter No. 136 were taken while sewage was passing through.

Comparing the analyses of air from the two filters, it will be noticed that in April and May the oxygen primarily present in the air within Filter No. 135 was only slightly decreased in the samples taken at different depths, and hence the percentage of nitrogen present in the air of the filter could not have changed materially, and yet nitrification did not occur to any extent; while, on the other hand, the analyses of air from Filter No. 136 showed practically a complete exhaustion of oxygen without a corresponding increase in carbon dioxide, that is, the atmosphere in the filter was almost entirely nitrogen.

At the beginning of June, then, Filter No. 136 was practically an anærobic filter, and very poor results were being given by Filter No. 135, even though it had within it a considerable percentage of oxygen at times. On June 20, 6 feet in depth of filtering material was removed from each filter, making the depth of each 11 feet 10 inches. Following this, nitrification started immediately in Filter No. 136, its effluent containing more than 3 parts of nitrates per 100,000 parts in less than two weeks after this change, and during the months of July, August and September the effluent of this filter, both in the high amount of nitrate present and in the small amount of unoxidized organic matter, approximated the good quality of the effluents of sand filters, operated at about one-twentieth as great a rate; during these months the rate of operation of the filter averaging about 1,200,000 gallons per acre daily. The reason for this improved result was without doubt that in this instance, with only 12 feet in depth of filtering material, a better circulation of air was obtained; but this does not by any means prove that 18-foot filters cannot be operated successfully if the proportion of surface area to depth is increased.*

Contact Filter No. 135, after lessening its depth, also gave a much better result than before, but did not by any means attain the

* Early in the present year, 1901, it was found that, when these filters became charged with an atmosphere of nitrogen and nitrification was prevented, nitrogen could be expelled and air drawn into the filters by operating them for a day or two as contact filters; that is, by filling and draining them, the conditions prevailing in the filters could generally be changed and nitrification re-established.

efficiency of continuous intermittent Filter No. 136, as shown by the tables of analyses beyond. The reduction in depth of this filter caused, of course, an apparent reduction in the rate of operation, although the rate per depth of filtering material was as great as before the removal of the upper 6 feet of broken stone. With the advent of colder weather nitrification became less active in both filters, although continuing to a much greater degree in Filter No. 136 than in Filter No. 135, and it is noticeable that in the month of December, when the applied sewage and effluent of this filter were at a temperature of about 51° Fahrenheit, there were in its effluent 3.74 parts nitrates per 100,000 parts. The effluent of Filter No. 135 did not at this time begin to compare in degree of purification with the effluent of Filter No. 136, and the nitrates were only about one twenty-fifth as high.

The difference in bacterial destruction or removal by these two filters is especially noticeable; the average number of bacteria per cubic centimeter present in the effluent of Filter No. 135 being 349,000 for the year, and in the effluent of Filter No. 136, 70,000 for the year, but the average number in Filter No. 135 is lowered considerably by the results obtained during the first three months of the year, when the filter was running at a low rate and not as a contact filter but as a continuous intermittent filter. In warm weather the several million of bacteria per cubic centimeter in the sewage applied to Filter No. 136 were reduced to about 2,000 per cubic centimeter in the effluent.

Series of Samples showing Percentage of Oxygen and Carbonic Acid Gas in Air from the Interior of Filter No. 135 at Different Dates and Different Hours.

May 4 and 5.			May 10 and 11.		
Time.	Per Cent. CO_2.	Per Cent. O.	Time.	Per Cent. CO_2.	Per Cent. O.
6.00 P.M.,	2.5	14.1	7.00 P.M.,	4.2	13.1
7.00 "	3.0	14.9	8.00 "	4.3	13.4
8.00 "	2.7	15.7	9.00 "	4.2	13.6
10.00 "	2.4	15.8	10.00 "	4.1	13.9
11.00 "	2.4	15.4	11.00 "	4.2	13.9
12.00 "	3.3	13.5	12.00 "	4.3	13.9
1.00 A.M.,	2.8	14.5	1.00 A.M.,	4.2	13.6
2.00 "	3.2	14.1	2.00 "	4.1	13.1
3.00 "	2.7	13.9	3.00 "	4.5	12.4
4.00 "	2.9	14.0	4.00 "	4.1	12.0
5.00 "	3.3	15.2	5.00 "	4.9	11.6
6.00 "	4.3	11.5	6.00 "	4.7	11.5
7.00 "	4.3	11.7	7.00 "	5.0	11.2
8.00 "	3.9	11.1	8.00 "	5.6	10.5
8.30 "	3.8	9.1			

Series of Samples showing Percentage of Oxygen and Carbonic Acid Gas in Air from the Interior of Filter No. 135 at Different Dates and Different Hours.

Date.	Time.	Per Cent. CO_2.	Per Cent. O.
April 13,	8.30 A.M.,	1.3	1.2
April 16,	8.30 "	0.5	0.7
May 1,	5.00 P.M.,	4.1	13.9
May 2,	8.30 A.M.,	5.3	7.5
May 2,	5.00 P.M.,	2.8	13.4
May 3,	7.30 A.M.,	7.1	7.9

Series of Samples showing Percentage of Oxygen and Carbonic Acid Gas in Air from the Interior of Filter No. 136 at Different Dates and Different Hours.

April 1.			May 9.		
Time.	Per Cent. CO_2.	Per Cent. O.	Time.	Per Cent. CO_2.	Per Cent. O.
9.30 A.M.,	1.9	0.5	9.00 A.M.,	1.2	0.0
1.30 P.M.,	1.2	0.0	10.00 "	1.6	0.0
3.00 "	1.3	0.7	11.00 "	1.6	0.6
4.00 "	1.5	0.0	12.00 M.,	2.0	0.7
5.00 "	1.7	0.7	1.00 P.M.,	1.7	0.5
			2.00 "	1.6	0.0
			3.00 "	2.2	0.5
			3.30 "	1.7	0.5
			4.00 "	1.7	0.0
			4.30 "	1.7	0.0
			5.00 "	1.3	0.5

Date.	Time.	Per Cent. CO_2.	Per Cent. O.
April 13,	8.30 A.M.,	1.3	1.0
May 11,	2.00 "	2.2	0.7
May 12,	2.00 "	2.7	1.3
May 13,	2.00 "	3.1	0.9
May 22,	5.00 "	6.8	2.8
October 17,	– –	4.5	8.2

The following tables give the average analyses of the sewage applied to and the effluents from these filters: —

Average Analyses of Sewage applied to Filters Nos. 135 and 136.

[Parts per 100,000.]

	Temperature. Deg. F.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Total.	In Solution.	In Suspension.			
Sewage applied to Filter No. 135,	60	4.09	.62	.27	.35	9.02	4.31	1,499,400
Sewage applied to Filter No. 136,	62	4.67	.33	.22	.11	9.74	2.45	648,800

Effluent of Filter No. 135.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
January, .	508,400	49	52	Great.	0.61	3.7400	.1845	.1245	.0600	7.09	0.03	.0017	1.68	203,000
February, .	262,100	46	42	Great.	3.20	3.0400	.1720	.1360	.0360	6.88	0.03	.0030	1.46	74,000
March, .	986,500	49	46	Slight.	0.30	1.0667	.0587	.0510	.0077	4.02	1.04	.0151	0.53	32,800
April, .	1,742,700	55	50	Decided.	0.54	3.4667	.1840	.1267	.0573	8.72	0.24	.0204	1.46	404,500
May, . .	2,645,200	60	57	Decided.	0.48	2.1200	.1784	.1464	.0320	7.94	0.42	.0098	1.14	281,200
June, .	2,126,000	75	69	Decided.	0.59	2.8150	.2170	.1600	.0570	12.95	0.01	.0000	1.57	328,300
July, . .	1,761,300	79	72	Decided.	0.65	2.2360	.2336	.1340	.0996	12.60	0.02	.0014	1.38	346,400
August, .	1,761,300	76	77	Slight.	0.86	2.7000	.1360	.1120	.0240	13.39	0.46	.0550	1.00	167,000
September,	1,820,000	70	66	Slight.	0.49	2.1000	.1800	.1490	.0310	9.67	1.82	.0150	1.11	543,000
October, .	1,761,000	64	60	Decided.	0.79	2.6700	.2433	.1600	.0833	10.48	0.36	.0035	0.95	434,000
November,	1,577,000	57	50	Decided.	0.65	2.3000	.2240	.1960	.0280	8.06	0.49	.0024	1.40	909,000
December,	1,050,000	51	50	Decided.	0.85	2.6000	.2760	.1100	.1660	12.54	0.14	.0000	2.06	470,000
Average,	1,500,100	61	58	-	0.83	2.5712	.1906	.1338	.0568	9.53	0.42	.0106	1.31	349,400

Surface dug over to a depth of 8 inches, February 2; 6 inches, October 19. February 14 to February 19, experiment interrupted by freshet, and December 2 to December 17, by break in sewer pipe.

Effluent of Filter No. 136.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
January, .	446,500	49	52	Great.	.60	3.8800	.2030	.1085	.0945	7.19	0.02	.0044	1.61	220,000
February, .	248,000	46	42	Decided.	.25	3.2000	.1440	.1240	.0200	8.22	0.48	.0720	0.80	52,200
March, .	952,900	49	45	Decided.	.70	1.9067	.0893	.0840	.0053	4.82	0.26	.0065	0.69	44,700
April, .	1,091,300	55	50	Decided.	.63	3.6400	.1880	.1090	.0790	8.49	0.02	.0006	1.40	192,500
May, . .	425,200	60	57	Decided.	.75	5.7600	.2496	.1728	.0768	8.27	0.07	.0044	1.95	210,600
June, .	333,300	75	67	Decided.	.71	4.3500	.1510	.1085	.0425	11.97	1.12	.0748	1.42	44,200
July, . .	978,100	79	71	V. slight.	.43	0.3840	.0600	.0532	.0068	12.39	3.50	.0488	0.65	11,100
August, .	1,241,300	76	75	V. slight.	.33	0.0170	.0398	-	-	13.25	3.65	.0012	0.38	2,300
September,	1,304,000	70	65	None.	.28	0.2202	.0484	-	-	11.43	4.18	.0018	0.48	2,350
October, .	1,413,000	64	60	V. slight.	.49	1.0760	.0959	-	-	10.04	2.48	.0173	0.98	20,200
November,	1,368,000	57	50	Slight.	.69	2.5000	.1400	.1080	.0320	8.26	1.09	.0120	1.00	22,100
December,	888,000	51	52	Slight.	.90	1.5000	.1520	.1280	.0240	10.16	3.74	.0012	1.30	14,600
Average,	890,800	61	57	-	.56	2.3695	.1301	.1107	.0194	9.54	1.72	.0204	1.06	69,700

Surface dug over to a depth of 8 inches, February 2. December 2 to December 17, experiment interrupted by break in sewer pipe.

Comparison of a Contact Filter and an Aerated Filter, Both of Coarse Material.

Filters Nos. 137 and 138, $\frac{1}{20000}$ of an Acre in Area.

Considerable discussion was given in the last report concerning the comparatively rapid accumulation of organic matter in aerated filters of fairly coarse material, such as Filters Nos. 15 A and 16 B, formerly in operation at the station, in which the bacterial action was always, or at least always intended to be, ærobic, compared with the comparatively slow accumulation of organic matter in contact filters in which the bacterial action may be both ærobic and anærobic. In February, 1900, Filters Nos. 137 and 138 were put into operation to further study this subject. They are constructed of coarse broken stone of such a grade that all the pieces will pass through a sieve with a 1-inch mesh and practically none through a sieve with a ½-inch mesh. They were each operated during the year at a rate of 480,000 gallons per acre daily, Filter No. 137 being a contact filter and receiving its sewage in three applications two hours apart, and its outlet opened after the last application of sewage. Filter No. 138, on the other hand, had sewage applied to it three times per day from February 21 to April 29 and twelve times per day from April 30 throughout the remainder of the year, its outlet always remaining open.

As a result of the operation of these two filters of duplicate construction, at equal rates but by different methods, we find upon comparison that, although the effluent of Filter No. 137 (contact) has contained the greatest amount of nitrates during only four months, yet the amount of albuminoid ammonia in its effluent has been the lowest during seven months. The organic matter designated by the determination of oxygen consumed has been lower in this filter five months of the year, and in addition to this an examination of the filters at the end of the year showed that, while the accumulation of organic matter within them both at that time was about equal, the organic matter in Filter No. 137 was of a more decayed nature and more easily oxidized than the organic matter that had accumulated in the aerated Filter No. 138. This was shown both by the percentage that the albuminoid ammonia determination was of the Kjeldahl determination and by examination, the

material from Filter No. 137 being darker colored and having an offensive odor, as compared with the lighter colored and less odorous matter from Filter No. 138.

The operation of these two filters for the year has to a certain extent proved the statements made in previous reports in regard to the comparative degree of clogging of aerated filters and contact filters, but they would have been more successful, apparently, in showing this difference if we had selected a finer material for use in these filters than we have used; that is, one with the voids of its open space smaller and allowing a less free flow of sewage through; in fact, a material like that formerly in Filters Nos. 15 A and 16 B. The odor of the effluent of Filter No. 138 was more agreeable than the odor of the effluent of Filter No. 137 throughout the year.

Effluent of Filter No. 137.

[Parts per 100,000.]

1900.	Quantity Applied.	Temperature. Deg. F.		Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Gallons per Acre Daily for Six Days in a Week.	Sewage.	Effluent.	Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
February,	917,100	46	45	Great.	0.67	1.7200	.1560	.1360	.0200	4.32	0.160	.0210	1.38	272,000
March,	800,000	46	45	Great.	0.48	1.5400	.1250	.0890	.0360	3.91	0.440	.0106	0.97	222,800
April,	864,000	47	53	Great.	0.88	3.1000	.3240	.2280	.0960	7.94	0.013	.0000	2.18	863,500
May,	454,800	54	58	Decided.	0.43	2.2500	.2990	.1960	.1030	9.19	3.273	.0114	1.83	569,100
June,	253,800	68	72	Slight.	0.42	1.9500	.1940	.1220	.0720	17.30	1.740	.0250	1.32	112,000
July,	480,000	74	75	Decided.	0.57	1.7000	.2147	.1480	.0667	13.51	1.050	.0533	1.41	458,200
August,	480,000	72	75	Decided.	0.51	1.6300	.1520	.1150	.0370	10.45	0.580	.0071	1.30	544,500
September,	480,000	70	66	Decided.	0.44	2.0500	.2000	.1190	.0810	11.25	2.046	.0017	1.27	1,041,000
October,	480,000	60	66	Decided.	0.65	2.2000	.2720	.1500	.1220	9.40	0.990	.0060	1.66	886,000
November,	415,400	52	56	Decided.	0.55	2.6000	.2720	.2000	.0720	10.30	0.860	.0220	2.00	731,000
December,	240,000	51	49	Decided.	1.00	2.6000	.3560	.3080	.0480	7.47	0.960	.0520	2.88	373,000
Average,	533,000	58	60	-	0.60	2.1200	.2332	.1646	.0686	9.55	1.101	.0191	1.65	552,100

Fifteen gallons of sewage applied eighteen times a week, February 21 to May 6; 42 gallons daily (15 gallons at 7 and 9 A.M., and 12 gallons at 11 A.M.), May 7 to May 14; 5 gallons daily, May 15 to May 27; 5 gallons twelve times a week, May 28 to June 25; 6 gallons 24 times a week, June 26 to December 31. March 3 to March 6, experiment interrupted by freshet, and December 3 to December 17, by break in sewer pipe.

Effluent of Filter No. 138.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
February, .	917,100	46	43	Decided.	.39	1.0200	.0800	.0600	.0200	3.01	0.140	.0034	0.64	208,000
March, .	900,000	46	44	Decided.	.33	0.8800	.0720	.0520	.0200	3.15	0.450	.0102	0.59	207,800
April, .	811,200	47	50	Great.	.83	2.9000	.3320	.2600	.0720	7.31	0.021	.0000	2.42	1,109,000
May, . .	480,000	54	57	Slight.	.50	1.2750	.1530	.0895	.0635	8.85	2.035	.0085	1.30	335,400
June, . .	480,000	68	72	Slight.	.87	1.5000	.2480	.0920	.1560	11.54	1.048	.0075	1.50	137,800
July, . .	480,000	72	76	Slight.	.45	1.3167	.3080	.0867	.2213	12.22	1.939	.0110	1.84	226,300
August, .	448,900	74	75	Slight.	.48	1.4100	.2920	.0840	.2080	17.02	1.592	.0132	1.66	252,000
September,	480,000	60	66	Slight.	.39	0.9700	.2700	.0600	.2100	10.69	2.343	.0102	1.66	698,000
October, .	480,000	60	61	Decided.	.60	1.1600	.2880	.1220	.1660	10.49	1.620	.0070	1.52	514,000
November,	398,500	52	56	Decided.	.80	2.8000	.2920	.1400	.1520	11.59	0.030	.0022	1.48	404,000
December,	240,000	51	46	Decided.	.75	2.8000	.2640	.1440	.1200	8.09	3.170	.1300	2.10	159,000
Average,	556,000	57	59	–	.58	1.6392	.2363	.1082	.1281	9.45	1.308	.0185	1.52	386,400

April 30 to September 19, filter aspirated from 9 P.M. to 5 A.M. daily. December 3 to December 17, experiment interrupted by break in sewer pipe.

Treatment of Sewage with Iron before Filtration in a Contact Filter.

Filter No. 82, $\frac{1}{20000}$ of an Acre in Area.

This filter contained when first put into operation in September, 1897, 5 feet in depth of cinders freed from fine material. At the end of 1900 its depth was 4 feet 4 inches, about 2 inches of clogged material having been removed from its surface at one time, caused by the clogging resulting from an experiment upon the purification of wool liquor in this contact filter, and 6 inches in depth were removed also upon Jan. 20, 1900. This removal was necessitated not entirely by clogging caused by the accumulation of organic matter, but largely by the disintegration of the somewhat soft and friable cinders constituting this filter. The average rate of operation of the filter had been 527,000 gallons per acre daily during 1899, and at the beginning of 1900 the rate was practically the same, and a satisfactory contact filter effluent was being produced.

Beginning January 24, however, we began to apply sewage that had first passed up through a tank containing pieces of scrap iron, the idea being to cause the sewage to undergo anærobic action before filtration, and thus produce a better final effluent. As a result we did obtain for a few weeks from this filter an effluent containing less organic matter than ever before. Much iron was carried in solution and in suspension in the sewage upon and into the filter, however, and there coated the cinders to such an extent that the filter began finally to act in a manner similar to an iron contact filter as described in the last report upon page 473 and upon subsequent pages in this report. Nitrification as a consequence practically ceased within the filter, and the rate of operation had to be very materially reduced, owing to this clogging with precipitated iron. On May 20, untreated sewage was again applied, but not until August had enough iron been carried away from the filter with its effluent to allow oxidation and nitrification to again become active. The table of analyses beyond shows the large amount of iron appearing in the effluent of this filter during the months of May, July and August.

Effluent of Filter No. 82.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Iron.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.			
Jan., .	191,200	47	44	Decided.	0.67	0.7000	.0760	.0700	.0060	5.25	0.92	.0080	0.80	-	66,500
Feb., .	519,200	46	45	Decided.	0.49	0.2333	.0660	.0600	.0060	4.09	1.04	.0093	0.55	-	114,800
Mar., .	606,500	46	43	Decided.	0.38	0.1900	.0520	.0240	.0280	4.36	1.07	.0030	0.43	-	108,000
Apr., .	448,600	47	55	Great.	0.62	1.6800	.1880	.1340	.0540	7.03	0.06	.0000	1.40	-	416,300
May, .	484,600	54	55	Decided	0.40	1.6000	.6547	.2993	.3554	8.50	0.11	.0001	1.37	.3250	403,300
June,	432,700	68	66	Decided	3.88	3.2500	.2720	.1520	.1200	11.13	0.01	.0000	2.93	-	505,000
July, .	471,700	72	74	Decided.	0.76	2.1500	.1900	.1080	.0820	10.98	0.04	.0006	1.56	.6560	455,000
Aug., .	331,900	72	70	Decided.	1.12	1.2000	.1580	.0930	.0650	12.00	0.69	.0165	1.02	.1880	420,000
Sept., .	358,500	70	67	Slight.	0.52	1.2150	.1430	.1330	.0100	13.67	0.37	.0170	0.76	.0800	845,000
Oct., .	419,300	60	60	Decided.	0.73	1.5600	.2060	.1770	.0290	9.06	0.41	.0072	1.05	.0690	1,238,000
Nov., .	344,700	52	54	Decided.	0.55	1.3000	.1440	.1420	.0020	13.09	0.97	.0004	0.87	.1280	271,000
Dec., .	182,500	51	45	Decided.	0.43	0.1400	.0840	.0760	.0080	7.09	2.90	.0060	0.92	-	32,500
Av.,	399,300	57	57	-	0.88	1.2682	.1861	.1224	.0637	8.85	0.72	.0057	1.14	.2410	406,300

Ten gallons of sewage applied forty-two times a week, January 1 to June 14; 53 gallons six times a week (five doses of 10 gallons each and one dose of 3 gallons), June 15 to December 17; 10 gallons thirty times a week, December 18 to December 31. January 24 to May 20, filter received sewage which passed upward through a tank filled with scrap iron and overflowed on this filter. After April 9, filter operated in periods of five weeks each and allowed to rest every sixth week. Filter allowed to rest June 25 to June 30, and aspirated from 8 A.M. to 4 P.M. daily. January 20, 8 inches of material removed. Surface dug over to a depth of 6 inches April 5, May 18, June 25, October 14. November 26 to December 17, experiment interrupted by break in sewer pipe.

FILTRATION OF STRAINED SEWAGE IN A SHALLOW CONTACT FILTER COMPARED WITH FILTRATION OF UNTREATED SEWAGE IN A DEEPER CONTACT FILTER.

Filters Nos. 108 and 108A, $\frac{1}{20000}$ of an Acre in Area.

Filter No. 108 contained, at the beginning of the year, 2 feet in depth of pieces of fine coke free from coke dust, and at that time it was receiving, at the rate of 300,000 gallons per acre daily, the effluent of the coal strainer (see page 370), operating at the rate of 1,000,000 gallons per acre daily. Upon March 12 the rate of operation of the filter was increased to approximately 600,000 gallons per acre daily, this necessitating two fillings of this shallow contact filter each day. Following this change in operation, the character of the effluent became decidedly poorer, both from a chemical and a bacterial standpoint. Upon June 1 the depth of the filter was doubled, the coke in use being mixed with new coke of a somewhat coarser grade and the rate of operation made twice as great. This practically new filter was designated No. 108A. During the period from January 1 to August 10 the effluent of the coke strainer continued to be applied, but during the period from August 10 to December 31 regular untreated Lawrence sewage was applied. This allowed a direct comparison of the results obtained when filtering strained sewage in a shallow contact filter from January 1 to June 1, with the results obtained when filtering untreated sewage in a contact filter of twice as great a depth from August 10 to December 31, as shown by the following tables:—

Effluent of Filter No. 108.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Appearance. Turbidity.	Appearance. Color.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. In Solution.	Albuminoid Ammonia. In Suspension.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, .	268,900	49	44	Great.	0.58	1.3000	.1720	.1150	.0570	9.33	1.04	.0010	1.65	202,500
February, .	261,300	46	47	Decided.	0.45	0.3700	.0820	.0660	.0160	3.98	1.22	.0020	0.63	217,300
March, .	550,000	49	44	Slight.	0.37	0.3600	.0560	.0520	.0040	4.44	1.54	.0018	0.49	141,500
April, .	570,200	55	50	Great.	0.46	1.1925	.1725	.1170	.0555	7.60	1.23	.0055	1.40	434,800
May, . .	506,000	60	56	Decided.	0.38	0.8000	.1580	.1040	.0540	9.69	1.04	.0139	1.30	463,000
Average,	431,300	52	48	-	0.45	0.8045	.1281	.0908	.0373	7.01	1.21	.0048	1.09	291,800

Effluent of Filter No. 108 A.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
August, .	705,200	76	71	Decided.	0.33	1.8500	.1320	.0590	.0730	13.06	1.34	.0285	0.88	313,800
September,	544,000	70	61	Decided.	0.63	1.4000	.1840	.1320	.0520	11.30	3.69	.0014	1.36	276,000
October, .	528,900	64	59	Decided.	0.65	1.6500	.1260	.1060	.0200	10.05	0.88	.0008	0.89	889,000
November,	601,500	57	62	Decided.	0.50	0.8000	.1540	.1100	.0440	11.05	2.42	.0036	0.94	521,500
December,	340,000	51	50	Decided.	2.75	0.2400	.2200	.0940	.1260	9.91	1.41	.0032	1.54	1,150,000
Average,	543,900	64	61	-	0.97	1.1880	.1632	.1002	.0630	11.07	1.95	.0075	1.12	630,000

Filter No. 131, $\frac{1}{10000}$ of an Acre in Area.

This filter consisted of six separate sections or filters, one above the other, and each section contained 10 inches in depth of coke of the grade in Filter No. 103 (see page 382) above 1 inch of coarse coke. There was a space of 4 inches between the bottom of one section and the top of the next, and hence the sewage became more or less aerated as it passed from one section to another. The filter was put into operation in September, 1899, and was continued during the first five months of 1900, a continuous stream of sewage flowing into an automatic tipping basin which emptied every four and one-half minutes. The average rate of operation during 1899 was 1,735,000 gallons per acre daily, and an effluent was produced that was purified to a considerable extent, containing considerable dissolved oxygen and with little odor. During its period of operation in 1900 the rate had to be constantly reduced, owing to a growth of *Crenothrix* upon the bottom and surface coke of each section, causing such a degree of clogging that almost daily rakings of the surface would not keep the filtering material open enough to allow the rapid passage of sewage, together with the circulation of air necessary for nitrification. The conditions obtaining in each of these sections were ideal for the promotion of this growth, that is, constant moisture, presence of air, partially purified sewage and iron from the coke.

Average Analysis of Sewage applied to Filter No. 131.

[Parts per 100,000.]

Temperature. Deg. F.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Total.	In Solution.	In Suspension.			
50	3.47	.47	.29	.18	6.63	3.37	1,648,000

Average Analysis of Effluent of Filter No. 131.

[Parts per 100,000.]

Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Color.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Sewage.	Effluent.			Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
864,200	46	45	.69	2.44	.1240	.0775	.0465	7.03	.61	.0072	.99	145,600

Discussion of the Results of Filters of Coarse Material operated at High Rates.

In the last report of the Board, upon pages 434–441 inclusive, considerable discussion was given in regard to various matters connected with the purification of sewage by means of contact filters. Chapters were given upon "Permanency," "Method of Operation," "Period of Time that Sewage should remain within a Contact Filter to give the Best Purification," and "Theory of Action within a Contact Filter." The conclusions there elaborated have not been changed materially by another year of investigation. The filters of coarse materials, operated at high rates during 1900, have been described, and the results obtained from them discussed in the preceding pages. These filters are fourteen in number, and have varied in depth of filtering material from 2 feet to 17 feet 10 inches, and the method of operation followed has varied greatly. The filtering material has, moreover, been of three kinds, — coke, cinders and broken stone. The sewage applied to these filters has varied from the regular station sewage to sewage in an advanced state of putrefaction, such as that from Septic Tank B and the Andover septic tank, and a discussion of the different results ob-

tained and the cause of these differences, as far as due to the sewage itself, has been given. The quality of the various effluents produced by these filters has varied greatly from other reasons, however, such as the character of the filtering material and the method and rate of operation.

The most satisfactory effluent produced for the entire year by these contact filters of coarse material, taking into account the rate of filtration, was that from Filter No. 103, containing 5 feet in depth of coke and operated at the average rate of 621,000 gallons per acre daily (see page 382). The next most satisfactory result for a considerable portion of the year was given by Filter No. 136, when operated during the last half of the year, in the intermittent continuous manner at an average rate for this period of 1,198,700 gallons per acre daily. The filter contained at this time 12 feet in depth of broken stone and received a sewage that before going to the filter passed through a storage tank, and was therefore exceedingly stale, with considerable of its organic matter in suspension removed (see pages 396–400). To give this result, however, the filter needed constant care and a careful distribution of sewage that it might be impossible to obtain with a filter of any considerable area. There was also the constant danger that growths, such as *Beggiatoa*, might throw it out of operation at any time. The effluent of Filter No. 134 during the year had passed through 10 feet in depth of broken stone, equally divided between upward filtration without air (anærobic) and downward filtration with air (ærobic), but at a slightly greater average rate, — 1,329,000 gallons per acre daily, — but was less purified than the effluent of Filter No. 136, however, although the upward filtration caused a greater removal of organic matter than did the tank through which the sewage for Filter No. 136 passed (see tables of effluent of Filter No. 133, page 394, and sewage applied to Filter No. 136, page 400). Coke Contact Filter No. 108A, receiving untreated Lawrence sewage at a rate equal to — allowing for difference in depth of the two filters — that of Coke Contact Filter No. 103, receiving the effluent of Septic Tank A, produced an effluent of nearly as satisfactory a degree of purity as Filter No. 103, but our experience has shown that its open space will be reduced more quickly and to a greater extent than has been the case with Filter No. 103.

Reduction of Open Space. — Permanency.

If the material of which a contact filter is constructed is firm and will not soften and crumble, the permanency of the filter depends upon the accumulation or non-accumulation within it of mineral or organic matter that decomposes slowly. A number of important observations upon this point have been made during the past year, but a discussion of them is postponed until more complete data have been secured.

Degree of Purification in Shallow Intermittent Sand Filters compared with Deeper Filters.

Filters Nos. 140, 141 and 141 A.

The question of the depth of filtering material necessary in sand filters to produce satisfactory and well-purified effluents has been given considerable attention during the year. The subject is of practical importance on account of the necessity in some cases — for instance, in Gardner at the present time — of constructing filter-beds by the removal of sand from one place to another rather than by the removal of surface loam from a sandy area. On this account this investigation was begun, although the subject has been given considerable attention, as noted in previous reports of the Board. Nearly all our sand filters at the station have been from 4 to 5 feet in depth, hence, in this study, filters of a less depth were used.

Filter No. 140 contained 2 feet in depth of fine sand of an effective size of 0.11 millimeter, and Filter No. 141, 3 feet in depth of sand of the same grade. The two filters were put into operation in June at a rate of 50,000 gallons per acre daily. Nitrification started almost immediately in each filter, and the effluent of each during the months of June, July and August was of an entirely satisfactory quality. The effluent of Filter No. 141, containing 3 feet in depth of material, contained considerably less organic matter, as shown by the determinations of albuminoid ammonia and oxygen consumed, than the shallower filter; but, as will be noted by referring to the tables of analyses, the amount in the effluent of the shallower filter was very small. At the end of August the filter containing 3 feet in depth of material was put out of operation, and in its place a filter was started, containing 2 feet in depth of sand of an effective size of 0.24 millimeter, that is, a sand much coarser than that in Filters Nos. 140 and 141. This Filter — No. 141 A — has been continued in opera-

tion throughout the year at a rate of 50,000 gallons per acre daily, and has produced a well-purified effluent, although not quite equal in quality to the effluent of Filter No. 140, of the same depth of much finer sand, as reference to the table of analyses beyond will show.

In regard to the use of filters upon a large scale of so shallow a depth as 2 feet, it is evident that no trouble will be experienced during warm weather in obtaining good results if the sand is as fine as either of the grades used in these experiments, but if in cold weather any considerable depth of these shallow filters should become frozen, only a slight depth of sand might be available for sewage purification. This would not generally be a difficulty to be met with in practice, however, as very few of the areas in the State become frozen except upon the very surface, the comparatively warm sewage applied keeping them practically free from frost.

Average Analyses of the Effluents of Filters Nos. 140, 141 and 141 A.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.		
Effluent of Filter No. 140, .	54,000	61	63	.08	.0899	.0145	10.31	2.77	.0056	.15	1,243
Effluent of Filter No. 141, .	50,000	70	72	.11	.0689	.0103	10.29	2.25	.0098	.10	152
Effluent of Filter No. 141 A, .	44,000	58	59	.13	.2278	.0381	11.66	2.22	.0089	.28	10,300

Application to Filters of Differing Volumes of Sewage containing Equal Amounts of Organic Matter.

Filters Nos. 128, 129 and 130.

As stated in the last report, the volume of sewage that can, in intermittent sand filtration, be applied to a filter and be satisfactorily purified, must in most instances vary with the degree of concentration of the sewage; that is to say, a town or city having a dilute sewage, owing to the extravagant use of its public water supply or to a large percentage of ground or surface water entering its sewage, should be able to purify this sewage at a greater rate per acre of filter-beds than a town having a small volume of a stronger sewage to purify. To illustrate this fact Filters Nos. 128, 129 and 130 were put into operation in August, 1899, and two of them — namely, Filters Nos. 128 and 130 — have been continued in opera-

tion throughout the year 1900, Filter No. 129 being put out of operation at the end of July.

These filters have each contained 5 feet in depth of sand of an effective size of 0.26 millimeter. To Filter No. 128 station sewage has been applied at an average rate of 91,300 gallons per acre daily; to Filter No. 129 the same volume of sewage plus an equal volume of river water, making the rate 189,000 gallons per acre daily; and to Filter No. 130, an equal volume of sewage plus twice as much river water, making the average rate for the year 274,000 gallons per acre daily. On account of this method of operation, the sewage applied to Filters Nos. 129 and 130 contained throughout a considerable portion of the year some dissolved oxygen, but this is not an uncommon occurrence where sewage mixed with ground water reaches a filtration area. During the latter part of the year, however, the mixture of sewage and river water stood long enough after mixture for the organic matter to exhaust the free oxygen present before the sewage was applied to the filters. A study of the tables of analyses will show that practically equal results were obtained from a chemical point of view, very little difference being noted in the organic matter present, as shown by the determinations of albuminoid ammonia and oxygen consumed, and the quantity of nitrate present in the effluent of each filter during the year was approximately equal when we consider that the effluent of Filter No. 130, which contained practically one-third as much nitrate as the effluent of Filter No. 128, was of three times the volume of the effluent of Filter No. 128. The best bacterial purification was given by the filter receiving the small volume of concentrated sewage and the poorest bacterial results by the filter receiving the large volume of dilute sewage. Tables of analyses follow:—

Average Analyses of the Effluents of Filters Nos. 128, 129 and 130.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
Effluent of Filter No. 128, .	91,300	57	57	.13	.0271	.0225	9.18	3.22	.0524	.25	6,500
Effluent of Filter No. 129, .	188,800	52	52	.16	.0194	.0281	3.99	1.62	.0027	.28	16,300
Effluent of Filter No. 130, .	273,700	55	55	.19	.0079	.0292	3.40	1.09	.0055	.31	25,600

Purification of Tannery Sewage.

Filters Nos. 155 and 156.

Beginning in 1895 and continuing for several years many investigations were made by the Board at the station and elsewhere in the State in regard to the purification of the sewage or waste liquor from tanneries, this waste liquor being often quite large in volume and containing generally, besides a very large amount of organic matter in different stages of putrefaction, a large amount of chemicals and dyestuffs, together with germicides used either in preserving the hides before tanning, in the removal of hair from the hides or in the process of tanning. These investigations showed that apparently all tannery sewage could be successfully purified if carefully studied and the right methods of purification followed.

During 1900 an application was received by the Board concerning the purification of the waste liquor of a certain tannery, and, as this liquor seemed to differ in some respects from the effluents of tanneries already examined, a short investigation has been made. Two small filters, Nos. 155 and 156, have been put in operation, each containing 5 feet in depth of sand of an effective size of 0.24 millimeter. To Filter No. 155 has been applied at the average rate of 63,000 gallons per acre daily the sewage from one drain at this tannery, which contains the waste liquor from certain processes necessary in tanning and coloring hides, together with a considerable portion of wool-scouring liquor. To Filter No. 156 sewage flowing from another drain of the tannery and resulting from preparing the hides for tanning has been applied at the same rate. Tables showing the average analyses of the sewage applied to and the effluent from each filter are given below.

It will be noticed that both produced good effluents, with fairly high nitrification. At the beginning of February, 1901, the mixed sewage — that is, the sewage from both drains — was applied to Filter No. 156, which was continued in operation for two months in this manner, and Filter No. 155 was put out of operation. It will be noticed from the tables that, after mixing the sewages, an effluent containing a much greater quantity of nitrates was obtained than when these two sewages were purified separately.

Effluent of Filter No. 155.

[Parts per 100,000.]

1900.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
October,	72,100	None.	.13	.0838	.0133	28.83	.14	.0019	.27	2,700
November,	64,800	None.	.24	.0045	.0241	14.95	.94	.0001	.42	1,700
December,	52,300	None.	.93	.0147	.0717	38.75	.42	.0000	.61	1,600
Average,	63,100	-	.43	.0343	.0364	27.51	.50	.0007	.43	2,000

Effluent of Filter No. 156.

[Parts per 100,000.]

1900.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
October,	71,800	60	60	Slight.	0.65	1.1867	0.0520	.0433	.0087	90.43	0.9200	.0287	0.44	11,800
November,	64,800	52	54	Slight.	0.59	0.1980	0.0651	-	-	176.53	2.3100	.0208	0.66	12,700
December,	52,100	51	45	V. slight.	0.63	0.0627	0.0963	-	-	137.55	2.3900	.0053	0.91	43,400
Average,	62,900	54	53	-	0.62	0.4825	0.0711	-	-	134.84	1.8700	.0183	0.67	22,600
1901. February,	70,900	50	50	V. slight.	1.05	0.3436	0.1030	-	-	6.19	6.2300	.0264	1.10	3,900
March,	96,100	50	54	V. slight.	2.00	0.0804	0.0780	-	-	9.85	4.5800	.0100	0.84	-
Average,	83,500	50	52	-	1.53	0.2120	0.0905	-	-	8.02	5.4000	.0182	0.97	3,900

Average Analysis of Sewage applied to Filter No. 156 during February and March, 1901.

-	-	-	-	-	-	0.3500	2.4400	-	-	15.61	-	-	8.40	-

Purification of Wool Liquor.

Filters Nos. 70 and 112.

Beginning as far back as 1895 and extending to the present year many methods of purifying the waste liquor from washing and rinsing wool have been experimented with at the station. As a

result of these various experiments it has been demonstrated (1) that, while a considerable amount of the matters in suspension in wool liquor will settle when the liquor is held quiet for sedimentation to take place, yet the amount of organic matter carried down cannot be increased materially by the addition of reasonable amounts of any of the chemicals commonly used as precipitants, either alone or in combination with each other; although combinations of ferric chloride and lime in considerable amounts, or lime alone, in some instances, will, when mixed with the liquor from some plants, cause the coagulation and precipitation of considerable organic and fatty matter; (2) that acids will cause a separation of the fats, but an acid liquor is produced that is difficult to treat; (3) that filtration of the strong wool liquor through sand filters is inexpedient, owing to the fact that this liquor will not nitrify by itself and these filters quickly become clogged; (4) that mixtures of the scouring liquor in different proportions with domestic sewage can be purified and nitrified by means of intermittent sand filters; (5) that, if the mixture is held for bacterial growth and putrefaction to occur before being applied to sand filters, it can be purified at a somewhat greater rate and with less clogging of the filtering material; (6) that mixtures of wool liquor and domestic sewage in a proportion that allows of purification in sand filters cannot be purified in contact filters; (7) that the liquor resulting from washing or rinsing wool after scouring can be purified at a high rate in sand filters when mixed with domestic sewage. In the various reports of the last five years will be found the investigations giving the reasons for these conclusions.

The two filters which began to be operated in September, 1898, with mixtures of domestic sewage and the wool liquor from the Bigelow Carpet Mills in Clinton, were continued in operation until the end of March, 1900. Each of these filters contained 4½ feet in depth of sand of an effective size of 0.23 millimeter, and were operated at practically equal rates during 1900, the mixture applied being 1 part wool liquor to 11 parts sewage. Before this liquor was applied to Filter No. 112 it passed through a septic tank, and was somewhat more easily disposed of on the filter because of this. Both filters, however, produced as good results as during the previous year (see report of 1899, pages 463–466) and were in good condition when put out of operation. The following tables give

the average analysis of the sewage applied to and the effluents from these filters during 1900: —

Sewage applied to and Effluents from Filters Nos. 70 and 112.

[Parts per 100,000.]

1900.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
Sewage applied to Filter No. 70,* . . .	-	-	-	-	-	3.6500	1.4300	7.49	-	-	16.40	-
Effluent of Filter No. 70,	47,600	43	43	V. slight.	2.15	0.0187	0.1683	5.62	1.63	.0000	2.83	17,500
Effluent of Filter No. 112,	46,100	43	48	V. slight.	1.73	0.0217	0.1440	6.46	2.91	.0023	2.25	7,600

* Sewage applied to Filter No. 112 was from the same mixture, but had passed through a septic tank.

On the Action of Iron in the Purification of Sewage.

Filters Nos. 88, 125, 139 and 150.

In the last report of the Board under this head it was said that the object of the experiments, in which metallic iron and iron oxide were used either directly or in admixture with sand, was to solve the question whether iron can be successfully employed as a carrier of oxygen and thereby assist the bacterial purification, and whether a chemical purification can be substituted to any extent for the action of micro-organisms. To the facts then available have been added another year's experience with filters of this character, which goes to show that the hydrous oxides of iron formed in the filter by the oxidation of metallic iron, and also native limonite, can act as oxidizing agents in the purification of sewage.

Filter No. 88, 20 inches in diameter, containing five feet in depth of sand of an effective size of 0.23 millimeter and iron filings in the proportion of 2 parts of sand to 1 of iron by bulk, was put into operation in July, 1897. In the account of the action of this filter in the last report it was shown that the increase of rate from 115,000 gallons per acre daily (at which rate it gave the best continuous results of any intermittent filter at the station) to 200,000 gallons per acre daily was followed by clogging and a decided deterioration in the character of the effluent. The attempt to maintain this higher rate was continued until April, 1900, without success, and the orig-

inal rate of 115,000 gallons was then resumed. From the table below it will be noticed that the effluent then regained its original character, showing that for a filtering medium of this nature and with sewage of the strength used the rate limit for regular working had probably been reached at 115,000 gallons per acre daily.

Effluent of Filter No. 88.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, .	148,100	47	47	12h. 22m.	V. slight.	.19	1.3868	.0467	9.24	1.06	.0048	0.38	2,667
February, .	108,300	46	50	16h. 28m.	V. slight.	.59	2.3000	.1630	6.09	0.14	.0022	1.32	4,695
March, .	200,000	46	48	3h. 7m.	Slight.	.62	1.6700	.0740	4.34	0.75	.0108	0.62	4,763
April, .	113,900	47	52	4h. 23m.	V. slight.	.16	1.2520	.0474	8.43	0.35	.0056	0.49	7,527
May, . .	115,300	54	52	1h. 35m.	V. slight.	.21	0.2896	.0207	7.33	2.23	.0220	0.24	4,636
June, . .	115,100	68	70	23m.	V. slight.	.24	0.0388	.0102	11.44	4.42	.0120	0.11	108
July, . .	115,100	72	74	14m.	None.	.12	0.0250	.0069	10.54	2.50	.0075	0.14	815
August, .	115,100	72	66	18m.	None.	.06	0.0070	.0072	10.25	2.95	.0030	0.07	94
September,	115,100	70	61	19m.	V. slight.	.19	0.0098	.0080	11.10	2.45	.0000	0.09	944
October, .	115,100	60	62	20m.	V. slight.	.10	0.0114	.0073	9.89	2.63	.0033	0.08	1,116
November, .	101,800	52	63	33m.	V. slight.	.15	0.0122	.0084	8.92	2.76	.0037	0.05	262
December, .	57,600	51	49	1h. 3m.	V. slight.	.12	0.0120	.0067	7.75	3.38	.0026	0.07	52
Average,	118,400	57	58	-	-	.23	0.5846	.0339	8.78	2.14	.0065	0.31	2,300

Two and one-half gallons of sewage applied six times a week, January 1 to April 2; 12 gallons six times a week, April 3 to December 31. Surface raked 3 inches deep once each week. Surface dug over to a depth of 6 inches, February 28. February 14 to February 18, experiment interrupted by freshet, and December 3 to December 17, by break in sewer pipe.

Filter No. 125, as stated in the last report, consists entirely of a natural limonite, — hydrous sesquioxide of iron, — of an effective size of 1.00 millimeter. This has been operated as a contact filter, for which, as has been already said, it is poorly adapted, owing to the fact that the fragments are too fine for the method. This filter, however, has served a useful purpose in showing the ease with which this oxide of iron parts with its oxygen to oxidize the organic matter in the sewage. This was already indicated in the last report, and the results for the past year show this action of the oxide of iron very satisfactorily. Beginning with 1900 this filter was operated at the

rate of approximately 400,000 gallons per acre daily, which proved too great for the material, and 6 inches of the clogged surface material had to be removed. Again this rate was tried, but clogging continued and nitrification did not improve. From July 1 to 16 the filter was allowed to stand filled with sewage, and small samples of the effluent taken from day to day showed large amounts of iron in solution in the ferrous condition, a proof of the oxidation of the organic matter by the limonite. At the end of this period the filter was drained, and was then found to be in such a condition that it could be successfully operated at the rate of 480,000 gallons per acre daily, with good nitrification. This is a more complete removal of clogging materials by resting than was ever before obtained at the station when using sand or broken stone, and can only be attributed to the beneficial action of the oxide of iron present. The smaller rate noted in the table during December was due to an accident to the sewer pipe, whereby the supply of sewage was cut off during a portion of this month.

Effluent of Filter No. 125.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Appearance. Turbidity.	Appearance. Color.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. In Solution.	Albuminoid Ammonia. In Suspension.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, .	382,200	47	46	Decided.	0.39	2.2800	.1060	.1020	.0040	7.75	0.26	.0060	0.89	99,800
February, .	100,000	46	44	Slight.	0.21	0.4400	.0560	–	–	3.98	0.00	.0006	0.61	97,000
March, .	391,100	46	49	Slight.	0.27	0.3240	.0720	.0540	.0180	5.42	1.37	.0238	0.50	124,800
April, .	302,400	47	53	Slight.	0.35	2.3667	.1253	.1000	.0253	7.93	0.03	.0019	0.86	286,200
May, . .	411,100	54	53	Slight.	0.45	3.0500	.1090	.1000	.0090	7.66	0.21	.0068	0.85	165,800
June, .	100,000	68	68	V. slight.	0.47	4.8000	.1287	.0927	.0360	11.56	0.16	.0187	0.78	43,700
July, . .	147,100	72	77	Decided.	0.27	1.5867	.1800	.1133	.0667	10.31	7.23	.0433	1.26	256,100
August, .	480,000	72	72	Slight.	0.26	0.1150	.0560	.0520	.0040	13.27	3.38	.0108	0.62	83,000
September,	480,000	70	61	Slight.	0.37	0.0460	.0980	.0880	.0100	9.07	2.08	.0018	0.80	112,500
October, .	480,000	60	65	Slight.	0.30	0.0540	.0780	.0740	.0040	9.26	3.25	.0024	0.78	287,600
November,	415,400	52	62	Decided.	0.52	0.2850	.1120	.0950	.0170	8.87	2.75	.0040	0.88	116,300
December,	240,000	51	49	Decided.	1.00	0.6200	.1920	.1520	.0400	8.54	3.95	.0080	1.30	287,300
Average,	327,400	57	58	–	0.41	1.3306	.1094	.0930	.0164	8.64	2.06	.0107	0.84	163,300

Filter No. 150, consisting of 5 feet in depth of a mixture of equal bulk of sand of an effective size of 0.23 millimeter and limonite of

the same character and size as in Filter No. 125, was put into operation in August, 1900. At the rate of 100,000 gallons per acre daily, nitrification began promptly, and the effluent was comparable to that of Filter No. 88. The low rate in December was due to the same cause mentioned above. The action of this filter goes to show that the admixture of a natural hydrous oxide of iron with sand gives the same results as the oxide freshly formed on the fragments of metallic iron. And, inasmuch as the action of the natural oxide of iron is not complicated with the reducing action of the metallic iron, the natural product is to be preferred.

Effluent of Filter No. 150.

[Parts per 100,000.]

1900.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Effluent (Temperature. Deg. F.).	Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
				Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
August,	100,000	71	3m.	None.	.07	.0353	.0117	9.02	0.22	.6508	.71	8,200
September,	100,000	65	3m.	None.	.05	.0021	.0080	12.00	3.52	.0011	.08	225
October,	100,000	64	3m.	None.	.06	.0020	.0072	9.53	2.83	.0280	.08	1,500
November,	88,500	58	11m.	None.	.06	.0057	.0097	8.77	3.01	.0077	.15	1,756
December,	50,000	47	6m.	–	.13	.0016	.0092	8.69	3.70	.0010	.12	343
Average,	87,700	61	–	–	.07	.0093	.0092	9.60	2.66	.1377	.23	2,405

Five gallons of sewage applied six times a week. Surface raked 3 inches deep once each week. December 3 to December 17, experiment interrupted by break in sewer pipe.

Filter No. 139 is a contact filter containing 4½ feet in depth of a mixture in equal proportions of pieces of metallic iron and coke. The mixed material is fairly coarse, and the filter has been operated during the months of February and March at a rate approximating 2,000,000 gallons per acre daily. Owing to clogging, this rate was reduced April 3 to about 1,400,000 gallons per acre. During this period no nitrification occurred in the filter, but the free ammonia of the applied sewage was reduced about 30 per cent., the albuminoid ammonia about 70 per cent., and the carbonaceous matters, shown by the determination of oxygen consumed, about 75 per cent. Beginning May 6 the filter was operated intermittently at the rate of 100,000 gallons per acre daily, and so continued until September 19. During this second period the nitrates in the months of May

and June averaged .10 of a part per 100,000, but were practically absent from the effluent during July, August and September. Notwithstanding this small amount of nitrification, the free ammonia of the applied sewage was reduced 70 per cent., the albuminoid ammonia 75 per cent., and the oxygen consumed about 75 per cent. It will be noticed that, comparing one period with another, there was little advantage in operating the filter intermittently at a low rate, as far as the percentage reduction of albuminoid ammonia and oxygen consumed was concerned, but the free ammonia was very greatly reduced during the period of intermittent operation.

The only comment to be made on the action of this filter is that the action of the metallic iron seemed to predominate, and that hydrous oxide of iron did not form to a sufficient extent to be operative. Similar action was noticed in Filter No. 96, described in the report for 1898.

Effluent of Filter No. 139.

[Parts per 100,000.]

1900.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Effluent (Temperature. Deg. F.).	Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
February, .	1,920,000	42	Great.	0.64	2.0000	.1160	.0720	.0440	4.12	.023	.0090	1.04	343,000
March, .	1,920,000	45	Great.	0.55	2.8800	.1880	.1040	.0840	5.62	.008	.0002	1.02	361,500
April, . .	1,498,000	51	Great.	0.55	3.7000	.2840	.1510	.1330	8.75	.010	.0001	1.52	732,800
May, . .	378,000	51	Decided.	0.41	2.0000	.2400	.0702	.1698	9.18	.114	.0106	1.73	318,500
June, . .	100,000	66	Slight.	0.88	1.3000	.1940	.1200	.0740	9.97	.106	.0245	1.14	349,500
July, . .	100,000	79	Great.	1.06	1.0000	.1800	.1000	.0800	10.75	.005	.0067	1.20	419,000
August, .	100,000	73	Great.	0.70	1.5000	.2360	.1680	.0680	8.43	.035	.0020	1.20	375,000
September, .	352,000	57	Great.	1.10	1.7200	.2040	.1180	.0860	7.89	.000	.0170	1.16	590,000
Average,	796,000	58	-	0.74	2.0100	.2053	.1129	.0924	8.09	.038	.0088	1.25	436,200

Cinders and Ashes as Filtering Materials.

Intermittent Filter No. 95.

Filter No. 95 contains 4½ feet in depth of cinders and ashes from the combustion of soft coal, and was put into operation in October, 1897. It has been continued throughout the year 1900, and at approximately the same rate of filtration as that at which it was started,

namely 100,000 gallons per acre daily. During the first part of the year it was slightly clogged and the effluent obtained was not quite equal to that of previous years. Upon May 7 the surface material was dug over to a depth of from 6 to 8 inches, and following this as good purification was obtained as in previous years, the effluent, after this date, having no turbidity, hardly any color and high nitrates. This filter is an illustration of what could be done on a very much larger scale by the use of waste ashes, cinders, etc., for the construction of filters where sand of a suitable quality cannot be found, the use of this material being especially applicable in the case of manufacturing establishments producing waste liquors that must be purified, and having at the same time a large output of ash and cinders from the coal consumed. Filter No. 5B, described on page 425, is another illustration of the use of this material in sewage purification.

Average Analysis of Effluent of Filter No. 95.

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Sewage.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.		
91,300	57	55	.09	.1110	.0221	8.53	2.98	.0006	.22	1,485

Operation of the Large Intermittent Experimental Filters, $\frac{1}{200}$ of an Acre in Area.

The large filters in the field outside of the station have accomplished their usual satisfactory work during the year. Some of these filters have been in operation thirteen years, and are still in good physical condition. It will be noticed by a comparison of the tabulated results of Filters Nos. 1, 6 and 9 A, as presented in the report for 1899 and in the present report, that their average rate of operation during 1899 was greater than during 1900, largely due to the greater volume of sewage applied during January, February and March, 1899, compared with that applied during the same months in 1900. It will also be noticed that, owing to this application of a large volume of sewage during these winter months, the filters were kept freer from frost and the effluents were better purified.

In the fall of 1894 all of these filters were rested for so long a period during cold weather that we were unable to obtain good nitrification within them again until the warmer weather of the following spring, the cold weather apparently destroying the nitrifying organisms within the filter. Various other experiments and observations have shown that, if a filter remains free from the application of sewage for a considerable period during cold weather, it is exceedingly difficult to start nitrification within it again until warmer weather returns, and also that new filtration areas in the State, put into operation in the late fall or early winter months, produce poor effluents during the first winter of operation; whereas filters started in warmer weather begin almost immediately to produce satisfactory results. From Nov. 24 to Dec. 17, 1900, a period of more than three weeks, we were unable to obtain any sewage at the experiment station on account of a break in our sewer pipe, which could not be repaired on account of the very high water in the river at that time. Remaining out of operation during the cold weather of this period of the year, nitrification again ceased within these large filters and consequently results were obtained during the winter of 1900–1901 similar to and in some instances even poorer than the results obtained during the winter of 1894–1895.

The following table shows the period of service of each of them, together with the date upon which they were started, their rate of operation, etc., and their average purification of sewage for the year 1900: —

Average Purification, etc., of Filters Nos. 1 to 10, inclusive, 1900.

Number of Filter.	Dimensions of Filters.		Date when Sewage was first Applied.	Actual Number of Gallons applied to Jan. 1, 1901.	Gallons per Acre.	Average Rate of Filtration (Gallons per Acre Daily) Six Days in a Week — 1900.	Average (1900) Per Cent. Removal of		
	Depth (Inches).	Mean Diameter (Inches).					Albuminoid Ammonia.	Oxygen Consumed.	Bacteria.
1, ...	63	200	Jan. 10, 1888,	1,525,200	305,040,000	51,900	91	86	99.11
2, ...	60	200	Dec. 19, 1887,	784,478	156,895,600	33,800	97	93	99.99
4, ...	60	200	Dec. 19, 1887,	506,776	101,355,200	17,800	98	97	99.99
5B, . . .	60	200	Mar. 5, 1898,	397,100	79,420,000	109,200	86	82	97.61
6, ...	44	200	Jan. 12, 1888,	1,124,089	224,817,800	51,700	91	87	99.14
9A, . . .	60	200	Nov. 18, 1890,	1,042,309	208,461,800	48,800	94	89	99.39
10, ...	60	200	July 18, 1894,	275,010	55,002,000	25,500	94	90	99.83

Filter No. 1.

Filter No. 1 contains 60 inches in depth of coarse sand of an effective size of 0.48 millimeter, and is $\frac{1}{200}$ of an acre in area. The surface of this filter has been raked 1 inch deep each week and spaded over to a depth of 6 to 8 inches upon April 9 and September 17. The following table gives the rate of operation and the monthly averages of the analyses of the effluent for the year: —

Effluent of Filter No. 1.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, .	46,700	47	40	6h. 30m.	Decided.	.64	2.1867	.1080	6.19	1.02	.0087	1.22	77,500
February, .	50,000	46	39	40m.	Decided.	.50	1.5200	.1080	4.17	1.28	.0053	0.95	6,100
March, .	60,000	46	40	22m.	Slight.	.17	0.2750	.0438	5.45	2.36	.0010	0.40	13,400
April, .	55,200	47	47	14m.	V. slight.	.25	0.3000	.0650	8.70	4.18	.0022	0.53	7,600
May, . .	60,000	54	55	12m.	V. slight.	.18	0.0324	.0460	7.85	4.75	.0002	0.37	13,900
June, . .	60,000	68	65	5m.	None.	.17	0.0443	.0328	12.01	4.28	.0000	0.32	4,650
July, . .	57,800	72	76	4m.	None.	.17	0.0692	.0422	14.23	3.13	.0009	0.39	15,950
August, .	44,400	72	76	7m.	None.	.07	0.1055	.0315	10.88	2.07	.0012	0.34	7,200
September,	45,600	70	71	5m.	None.	.24	0.3400	.0469	13.77	3.66	.0008	0.33	21,300
October, .	60,100	60	62	6m.	None.	.44	0.3385	.0487	8.75	2.43	.0007	0.56	36,500
November, .	46,200	52	51	21m.	V. slight.	.30	0.5600	.0700	9.02	2.82	.0008	0.52	29,700
December, .	36,900	51	43	7h. 30m.	Slight.	.78	1.5900	.1450	7.13	0.93	.0024	1.80	56,700
Average,	51,900	57	55	-	-	.33	0.6135	.0657	9.01	2.74	.0020	0.64	24,200

Three hundred gallons of sewage applied six times a week. During January, 12 inches of snow and 2⅝ inches of ice removed from surface; during February, 6 inches of snow and 3 inches of ice; during March, 5¼ inches of snow; during December, ½ inch of snow and 1⅛ inches of ice. Filter allowed to rest September 17 to September 23 inclusive. February 14 to February 18, experiment interrupted by freshet. November 26 to December 16, experiment interrupted by break in sewer pipe.

Filter No. 2.

This filter is $\frac{1}{200}$ of an acre in area and contains 60 inches in depth of fine sand of an effective size of 0.08 millimeter, with two circular trenches 1 foot wide and 2 feet deep, of medium sand of an effective size of 0.19 millimeter, the surface of these trenches being below the surface of the remainder of the filter, and to them the

sewage is applied. The surface of the trenches has been raked 1 inch deep each week and they were dug over to a depth of 6 to 8 inches April 9 and September 17. The following table gives the rate of operation and the monthly averages of the analyses of the effluent for the year: —

Effluent of Filter No. 2.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	31,900	47	43	12h. 45m.	V. slight.	.21	0.9100	.0270	8.05	1.66	.0850	.50	862
February, .	30,600	46	39	13h.	V. slight.	.18	1.3000	.0400	5.99	0.95	.0650	.61	1,358
March, .	38,500	47	40	7h. 36m.	V. slight.	.16	1.2100	.0300	2.85	1.53	.1125	.44	418
April, . .	36,800	47	46	2h. 27m.	None.	.16	1.0200	.0385	8.62	3.37	.0550	.40	203
May, . .	40,000	54	52	28m.	None.	.13	0.0468	.0268	10.08	4.54	.0000	.31	54
June, . .	40,000	67	63	6m.	None.	.14	0.0067	.0233	10.67	3.69	.0000	.28	14
July, . .	38,500	73	71	4m.	None.	.13	0.0026	.0186	10.59	3.96	.0002	.24	3
August, .	28,100	72	74	6m.	None.	.06	0.0028	.0194	14.06	3.78	.0000	.20	4
September,	30,400	69	71	5m.	None.	.11	0.0013	.0181	14.70	4.54	.0001	.17	18
October, .	40,000	60	64	7m.	None.	.14	0.0048	.0142	10.88	3.39	.0003	.19	12
November, .	26,500	53	54	32m.	None.	.10	0.0202	.0160	10.09	4.29	.0008	.22	26
December, .	24,600	50	45	2h. 53m.	None.	.20	0.0026	.0156	5.80	3.78	.0002	.25	52
Average,	33,800	57	55	-	-	.14	0.3773	.0240	9.70	3.29	.0266	.32	252

Two hundred gallons of sewage applied six times a week. July 14, cut grass and weeds on surface. During January, 12 inches of snow removed from surface, 3½ inches of ice and 3 inches of water from trenches; during February, 9½ inches of snow, 6 inches of ice and 9 inches of water; during March, 5 inches of snow, 1 inch of ice and 4 inches of water. Filter allowed to rest September 17 to September 23 inclusive. February 14 to February 18, experiment interrupted by freshet. November 26 to December 16, experiment interrupted by break in sewer pipe.

Filter No. 4.

This filter is $\frac{1}{200}$ of an acre in area and contains 60 inches in depth of fine river silt of an effective size of 0.04 millimeter, with two circular trenches about 14 inches wide and 12 inches deep, of coarse sand of an effective size of 0.48 millimeter. The surface of these trenches is below the surface of the remainder of the filter, and to them the sewage is applied. They have been raked 1 inch deep each week and spaded to a depth of 6 inches on April 9 and

September 17. The following table gives the rate of operation of the filter for the year and the monthly averages of the analyses of the effluent: —

Effluent of Filter No. 4.

[Parts per 100,000.]

1900.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January,	14,800	49	44	12h.	None.	.05	.0374	.0096	8.14	2.44	.0195	.14	69
February,	16,700	45	40	6h.25m.	None.	.05	.1266	.0196	7.32	1.39	.0350	.23	830
March,	21,000	45	40	3h.28m.	None.	.04	.1710	.0198	2.97	1.33	.0240	.20	276
April,	20,800	46	47	55m.	V. slight.	.05	.3500	.0170	5.00	2.32	.0110	.11	67
May,	20,700	54	54	25m.	None.	.00	.1128	.0144	7.38	4.40	.0004	.12	10
June,	20,000	67	63	4m.	None.	.00	.0291	.0112	8.43	3.45	.0001	.10	34
July,	20,000	72	68	5m.	None.	.03	.0012	.0126	11.22	3.08	.0000	.12	14
August,	14,800	72	74	7m.	None.	.04	.0008	.0126	14.18	3.17	.0001	.11	189
September,	14,400	69	69	6m.	None.	.01	.0019	.0108	13.46	3.83	.0016	.10	12
October,	19,300	60	64	9m.	None.	.02	.0009	.0081	12.27	4.14	.0001	.10	37
November,	13,800	55	57	21m.	None.	.05	.0016	.0106	9.59	4.58	.0000	.12	262
December,	16,900	49	47	8h.	None.	.15	.0008	.0090	7.61	3.96	.0000	.11	13
Average,	17,800	57	56	-	-	.04	.0695	.0129	8.96	3.17	.0077	.13	151

Two hundred gallons of sewage applied three times a week. July 14, cut grass and weeds on surface. During January, 8 inches of snow removed from surface, 3½ inches of ice and 2 inches of water from trenches; during February, 7½ inches of snow, 3½ inches of ice and 4 inches of water; during March, 5¼ inches of snow, 1½ inches of ice and 1 inch of water; during December, ¼ inch of snow. February 14 to February 18, experiment interrupted by freshet; and November 24 to December 17, by break in sewer pipe.

Filter No. 5 B.

This filter is $\frac{1}{200}$ of an acre in area and contains 60 inches in depth of a mixture of cinders and ashes from the combustion of soft coal. It was first put into operation on March 5, 1898, and was operated during that year at an average rate of 73,000 gallons per acre daily. During 1899 the average rate was 81,700 gallons per acre daily, and during 1900, 109,200 gallons per acre daily; but during a considerable portion of the year the rate was from 140,000 to 150,000 gallons per acre daily. Owing to the coarseness of the material in this filter, the sewage enters it more readily than it does any of the other large filters, and this is a condition especially

favorable for good work during cold winter weather. It will be noticed that, owing to this easy entrance of sewage into the filter before its temperature is lowered, nitrification was more active in the winter months in this filter than in any of the other out-door filters. The surface of the filter has been raked 1 inch deep each week and spaded to a depth of 6 to 8 inches upon April 9 and September 17. The following table gives the monthly averages of the analyses of the effluent: —

Effluent of Filter No. 5 B.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	81,500	48	40	7h. 15m.	Great.	0.62	1.9600	.1787	8.07	1.52	.1220	1.76	111,600
February, .	83,300	49	40	55m.	Decided.	0.32	0.4700	.0540	4.05	1.64	.1050	0.73	1,800
March, .	96,300	48	40	45m.	Slight.	0.14	0.2700	.0390	5.66	1.92	.1000	0.45	7,500
April, .	96,000	47	49	17m.	Decided.	0.52	1.2800	.1040	8.78	2.81	.0500	1.06	35,400
May, .	140,700	54	58	16m.	None.	0.13	0.1325	.0380	8.31	4.29	.0018	0.31	2,100
June, .	150,000	67	65	15m.	V. slight.	0.17	0.3960	.0610	11.08	3.12	.0010	0.42	9,850
July, .	146,200	72	75	14m.	V. slight.	0.17	0.4450	.0640	11.90	3.30	.0008	0.40	20,600
August, .	90,700	73	76	5m.	V. slight.	0.07	0.2595	.0445	11.27	3.87	.0004	0.32	30,000
September,	102,000	69	70	12m.	V. slight.	0.19	0.5919	.0570	13.30	3.83	.0008	0.35	38,900
October, .	146,300	60	62	19m.	Slight.	0.51	0.4125	.0860	9.75	2.82	.0021	0.65	42,000
November, .	98,100	54	51	22m.	Decided.	1.15	2.3000	.2600	9.57	2.64	.0048	1.76	381,300
December, .	78,800	49	42	52m.	Slight.	1.00	1.9800	.1700	6.28	2.29	.0036	1.46	102,000
Average,	109,200	58	56	–	–	0.42	0.8748	.0964	9.00	2.84	.0327	0.81	65,300

Five hundred gallons of sewage applied six times a week, January 1 to May 6; 750 gallons six times a week, May 7 to December 31. During January, 8 inches of snow and ⅝ inch of ice removed from surface; during February, 5 inches of snow and ⅞ inch of ice; during March, 6 inches of snow and ¼ inch of ice. Filter allowed to rest September 17 to September 23 inclusive. February 14 to February 18, experiment interrupted by freshet. November 24 to December 17, experiment interrupted by break in sewer pipe.

Filter No. 6.

This filter is $\frac{1}{200}$ of an acre in area and contains 44 inches in depth of mixed coarse and fine sand of an effective size of 0.35 millimeter. The surface of the filter has been raked to a depth of 1 inch each week and spaded to a depth of 6 to 8 inches on April 9

and September 17. The following table gives the rate of operation during the year and the monthly averages of the analyses of the effluent of the filter: —

Effluent of Filter No. 6.

[Parts per 100,000.]

1900.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	44,600	48	38	12h.	Decided.	.87	2.3867	.1440	7.88	0.82	.0200	1.54	16,600
February, .	50,000	46	37	3h. 22m.	Decided.	.64	2.1100	.1410	5.76	0.85	.0095	1.24	28,350
March, .	55,600	46	40	2h. 34m.	V. slight.	.19	0.5063	.0443	4.95	2.13	.0067	0.41	8,300
April, . .	59,600	47	48	12m.	Slight.	.22	0.3875	.0645	7.42	3.42	.0070	0.56	13,200
May, . .	60,000	54	58	19m.	None.	.26	0.0645	.0420	7.23	5.58	.0000	0.38	2,600
June, . .	60,000	68	66	6m.	None.	.18	0.0263	.0319	9.59	3.90	.0002	0.32	5,350
July, . .	60,000	72	78	6m.	None.	.16	0.1235	.0333	13.46	2.54	.0004	0.36	3,900
August, .	44,400	72	75	6m.	None.	.07	0.0068	.0276	11.25	3.60	.0000	0.28	3,200
September,	43,200	69	71	8m.	None.	.16	0.0354	.0242	11.26	4.05	.0003	0.22	1,150
October, .	60,000	61	63	17m.	None.	.18	0.0905	.0222	10.06	3.69	.0000	0.28	38,700
November, .	46,200	53	49	26m.	None.	.20	0.1124	.0252	9.75	3.17	.0000	0.31	158,300
December, .	36,900	50	39	3h. 24m.	V. slight.	.51	0.9970	.0975	6.98	1.10	.0003	0.77	3,975
Average,	51,700	57	55	-	-	.30	0.5706	.0581	8.84	2.90	.0037	0.56	23,600

Three hundred gallons of sewage applied six times a week. During January, 8 inches of snow and 2⅝ inches of ice removed from surface; during February, 6 inches of snow and 3¼ inches of ice; during March, 5 inches of snow. Filter allowed to rest September 17 to September 23, inclusive. February 14 to February 18, experiment interrupted by freshet. November 24 to December 17, experiment interrupted by break in sewer pipe.

Filter No. 9 A.

This filter is $\frac{1}{200}$ of an acre in area and contains 5 feet in depth of sand of an effective size of 0.17 millimeter. The surface of the filter has been raked 1 inch deep each week and spaded to a depth of 6 to 8 inches on April 9 and September 17. The following table gives the rate of operation during the year and the monthly averages of the analyses of the effluent of the filter: —

Effluent of Filter No. 9 A.

[Parts per 100,000.]

1900.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January,	46,700	44	38	4h. 43m.	Decided.	.69	3.3867	.1047	6.39	0.66	.0113	1.19	130,700
February,	50,000	41	38	6h. 41m.	Slight.	.45	1.7600	.0710	2.68	0.82	.0050	0.65	10,500
March,	53,300	43	40	3h. 5m.	Slight.	.40	0.9300	.0660	5.20	1.48	.0085	0.62	36,200
April,	40,800	48	49	1h. 4m.	V. slight.	.16	0.0212	.0344	7.11	3.68	.0000	0.42	200
May,	60,000	54	54	34m.	None.	.12	0.0476	.0345	7.49	4.80	.0016	0.31	800
June,	60,000	70	64	12m.	None.	.17	0.0197	.0238	10.29	4.17	.0000	0.27	46
July,	57,700	75	73	9m.	None.	.16	0.0128	.0292	14.68	4.83	.0000	0.31	67
August,	37,800	75	76	6m.	None.	.07	0.1000	.0215	10.66	4.56	.0000	0.28	68
September,	38,400	69	70	17m.	None.	.08	0.0658	.0209	11.88	3.97	.0001	0.24	42
October,	60,000	61	62	2h. 25m.	None.	.19	0.3319	.0294	10.20	3.52	.0003	0.39	8,036
November,	43,800	53	51	31m.	None.	.15	0.3448	.0344	9.35	2.82	.0000	0.35	746
December,	36,900	47	40	12h.	V. slight.	.81	1.3700	.1180	6.42	1.36	.0014	1.30	13,062
Average,	48,800	57	55	-	-	.29	0.6992	.0490	8.53	3.06	.0024	0.53	16,700

Three hundred gallons of sewage applied six times a week. During January, 8 inches of snow and 1 inch of ice removed from surface; during February, 7 inches of snow, 1⅛ inches of ice and 2 inches of water; during March, 5¾ inches of snow; during December, 1½ inches of ice. Filter allowed to rest September 17 to September 23, inclusive. February 14 to February 18, experiment interrupted by freshet. November 23 to December 17, experiment interrupted by break in sewer pipe.

Filter No. 10.

This filter is $\frac{1}{200}$ of an acre in area and contains 5 feet in depth of mixed coarse and fine sand of an effective size of 0.35 millimeter. No underdrains are beneath the sand except directly above and around the outlet pipe. A partition extending 3 feet below the surface separates the quarter of the surface farthest from the underdrains from the remainder of the surface. To this quarter of the surface the sewage is applied, and over the remainder of the surface is a depth of 8 inches of loam, this keeping the body of the filter freer from frost than is the case with most of the other filters and hence allowing better nitrification, as a general thing, in the winter weather; this being aided also by the small surface to which a comparatively large volume of sewage is applied. The following table gives the

rate of operation during the year and the monthly averages of the analyses of the effluent of the filter: —

Effluent of Filter No. 10.

[Parts per 100,000.]

1900.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, .	24,400	45	39	3h. 16m.	Decided.	.51	1.3200	.0953	7.72	1.07	.0360	1.09	16,500
February, .	25,000	42	36	1h. 2m.	Decided.	.56	0.9800	.1040	5.40	0.91	.0360	1.10	15,900
March, .	25,600	42	38	3h. 10m.	Slight.	.14	0.3550	.0448	4.75	2.27	.0203	0.32	6,600
April, . .	27,200	48	47	4h. 5m.	Slight.	.17	0.8400	.0500	8.32	4.25	.0560	0.73	6,700
May, . .	30,000	54	52	6m.	None.	.16	0.0452	.0364	7.19	3.16	.0000	0.32	6,200
June, . .	30,000	70	61	4m.	None.	.16	0.0532	.0293	10.04	2.99	.0000	0.27	788
July, . .	30,000	75	71	3m.	None.	.13	0.0420	.0324	15.39	3.84	.0002	0.32	594
August, .	21,100	74	73	2m.	None.	.07	0.0060	.0284	10.96	7.29	.0000	0.28	146
September,	22,800	70	70	7m.	None.	.13	0.0552	.0243	13.90	4.53	.0002	0.27	161
October, .	30,000	61	62	12m.	None.	.14	0.0454	.0166	8.91	3.64	.0001	0.26	201
November, .	21,900	53	54	15m.	None.	.12	0.0336	.0240	8.73	3.34	.0002	0.32	2,167
December, .	18,500	47	40	1h. 38m.	V. slight.	.28	0.1515	.0625	7.31	1.48	.0163	0.54	603
Average,	25,500	57	54	-	-	.21	0.3273	.0457	9.05	3.23	.0138	0.49	4,700

One hundred and fifty gallons of sewage applied six times a week. During January, 9½ inches of snow and ⅝ inch of ice removed from surface; during February, 9 inches of snow and 3½ inches of ice; during March, 6¾ inches of snow. February 14 to February 18, experiment interrupted by freshet. November 26 to December 17, experiment interrupted by break in sewer pipe.

FILTRATION OF WATER.

The principal investigations upon the filtration of Merrimack River water at the Lawrence experiment station during 1900 have been intended to show the efficiency of filters in removing the total number of bacteria present in the applied water compared with their efficiency in removing *B. coli*, these studies including a comparison of the efficiency of sand filters at different seasons of the year, with different depths of filtering material, and also a comparison of new and old filters, — that is, filters recently constructed and filters that have been in service for a number of years. We have also made studies of the frequency of the detection of *B. coli* when examining one hundred cubic centimeters as compared with its detection when examining one cubic centimeter of the effluents of filters receiving the river water, this study having considerable practical bearing upon the determination of the degree of purity of these effluents.

Besides this work, moreover, we have continued our investigations upon the removal of coloring matter from water by filtration, and have made some observations upon the removal of odors and organisms. These latter investigations are perhaps not as significant as they would have been if they had been made with a public water supply of high color or containing organisms, but have given us considerable information in regard to these subjects that is undoubtedly of value. We have also studied the microscopic organisms found upon the surface of sand filters and the part they play, if any, in aiding bacterial efficiency. A summary of all this work is given in the following pages, followed by a description of the various filters used in these investigations, including the Lawrence city filter, together with the usual tables giving the results of the chemical and bacterial analyses of the water applied to and the effluents from these filters.

Bacterial and B. Coli Efficiency of Sand Filters.

In the last two or three reports statements have been made to the effect that rates of filtration that are entirely satisfactory and successful in removing a large percentage of the total number of bacteria in the water applied to a filter may be, and probably are in some instances, too great for effective hygienic filtration when the water to be filtered is polluted to a degree equal or approximating that of the Merrimack River at Lawrence. That is to say, we have believed that the difference in the removal of pathogenic bacteria by a sand filter when operated at a high compared with a low rate of filtration may be greater than the difference in the removal of the total number of bacteria present in the water undergoing filtration, or, in other words, as the rate of filtration increases, the number of pathogenic organisms in the effluent may approach more rapidly nearer the number in the applied water than do the total bacteria in the effluent approach the total number in the applied water. Whether this is really so or not, however, we are not yet ready to definitely state, but the subject has been further investigated during the year 1900 and comparisons have been made of the results obtained during 1899 and 1900, when operating Filters Nos. 3 B and 8 A (see pages 471–476) at different rates during the two years. During both of these years, however, the rate of operation of these two filters was comparatively low, and while much more perfect filtration was attained during 1900 as regards the removal of *B. coli*, yet during both years the filters were probably producing safe effluents for all domestic purposes. A summary of much of our work upon the removal of *B. coli* by the filters follows.

Bacterial and B. Coli Efficiency of Filter No. 3 B (Intermittent) and Filter No. 8 A (Continuous) at Varying Rates.

During 1899 the average number of bacteria in the canal water (Merrimack River) applied to these filters was 5,700 per cubic centimeter; the average number in the effluent of Filter No. 3 B was 67 per cubic centimeter; and in the effluent of Filter No. 8 A, 32 per cubic centimeter. Filter No. 3 B during that year was operated at an average rate of 2,163,000 gallons per acre daily, and Filter No. 8 A at the rate of 2,598,000 gallons per acre daily.

Operated at this rate, and with the applied water containing the number of bacteria just stated, the bacterial efficiency of Filter No. 3 B was 98.80 per cent. and of Filter No. 8 A, 99.43 per cent. During that year the average number of *B. coli* in the applied water was 40 per cubic centimeter, and 22.27 per cent. of the samples of effluent of Filter No. 3 B that were examined contained a single colony of this germ, and 14.17 per cent. of the samples of effluent of Filter No. 8 A; that is to say, while the efficiency of each filter in removing *B. coli* was much greater than its general bacterial efficiency, still a considerable number of the samples of the effluent of each that were examined contained this germ. In January, 1900, the rates of these filters were reduced, and the average rate of operation during the year for Filter No. 3 B was 1,548,000 gallons per acre daily, or approximately 600,000 gallons per acre daily less than in the previous year, and the average rate of Filter No. 8 A for 1900 was 1,750,000 gallons per acre daily, or approximately 840,000 gallons per acre daily less than during the previous year. During this year the average number of bacteria in the applied water was 5,100 per cubic centimeter, the average number in the effluent of Filter No. 3 B was 47 per cubic centimeter, and the average number in the effluent of Filter No. 8 A was 22 per cubic centimeter, giving average bacterial efficiencies of 99.08 per cent. and 99.57 per cent., respectively; that is, decreasing the rate of Filter No. 3 B about 30 per cent. increased its bacterial efficiency only .28 per cent., and decreasing the rate of Filter No. 8 A 23 per cent. increased its bacterial efficiency only .14 per cent. Comparing the *B. coli* results, however, a much more marked difference is noted, as with the lower rate of 1900 the percentage of total number of samples of effluent of Filter No. 3 B that contained *B. coli* was 30 per cent. smaller, and the percentage of total number of samples of effluent of Filter No. 8 A that contained *B. coli* was 64 per cent. smaller than during the previous year. The following table illustrates this: —

Bacterial and B. Coli Efficiency of Filters Nos. 3 B and 8 A during 1899 and 1900.

SAMPLES FROM—	Average Number of Bacteria per Cubic Centimeter.	Per Cent. Removed (Efficiency).	Number of Samples Tested for B. Coli.	Number of Times B. Coli was Found.	Average Number of B. Coli.	Per Cent. of Samples Containing B. Coli.
1899.						
Canal water, . . .	5,700	-	297	287	40	96.63
Effluent of Filter No. 3 B, .	67	98.80	256	57	-	22.27
Effluent of Filter No. 8 A, .	32	99.43	247	35	-	14.17
1900.						
Canal water, . . .	5,100	-	288	288	49	100.00
Effluent of Filter No. 3 B, .	47	99.08	268	41	-	15.32
Effluent of Filter No. 8 A, .	22	99.57	275	14	-	5.09

Comparison of the B. Coli Efficiency of Deep and Shallow Filters, Old and New Filters.

Studies of the bacterial efficiency of Filters Nos. 3 B and 8 A during different periods and years of their operation were summarized in the report of the Board for 1899, these studies showing that their efficiency in this respect did not deteriorate as they became shallower by successive scrapings. The filters were growing older, however, with each year's use, and hence the coating of organic matter on the sand grains was growing deeper into the filter, or at least maintaining the same depth, notwithstanding the successive removals of surface sand. Moreover, as it has been proved that during periods of careful normal operation of sand filters one 2 or 3 feet deep is as efficient in removing total numbers of bacteria as one 4 or 5 feet deep, it is evident that the surface scum or schmutzdecke, with its abundant bacterial life, and the few inches of dirty sand under this are the principal factors in promoting good bacterial efficiency, although a considerable depth of sand is a further safeguard in assuring good results, especially at times of scraping or other surface disturbances. We should expect, then, other things being equal, that a filter containing 27 inches in depth of sand that had been in use several years would be more efficient than one of the same or greater depth, the sand of which had recently been placed in position, and that this is so is shown by the much greater *B. coli* efficiency of Filter No. 8 A, containing during 1900 only

slightly more than 2 feet in depth of sand that had been in use seven years, than that of Filter No. 143, containing 5 feet in depth of clean sand (see table, page 479). Their efficiency can properly be compared during only a portion of the year, however, as Filter No. 143 was not started until June 12; but, taking the five months from August 1 to December 31 inclusive, 127 samples of the effluent of Filter No. 8 A were examined and only 5 contained *B. coli*, or 3.9 per cent. of the total number; while of 126 samples of effluent of Filter No. 143 that were examined 18 contained *B. coli*, or 14.3 per cent.

B. Coli Efficiency of New Filters of Different Depths.

Comparing the new Filters Nos. 142 and 143 (see pages 476–479), operating at equal rates but containing 2 and 5 feet in depth of sand respectively, we find that their *B. coli* efficiency was practically equal during the year; this also agreeing with the generally accepted idea that it is the schmutzdecke and the upper inches of sand with considerable organic matter attached to the grains that remove most of the bacteria, for these two filters must have been equal in this respect during the year, although Filter No. 143 had the greater depth of sand for the water to pass through.

B. Coli Efficiency of Filters in Cold and Warm Weather.

Studying the tables of *B. coli* results given on pages 436–445, it will be noticed, as noted in previous reports, that the colder five months of the year are the ones when the poorest *B. coli* efficiency is given by all our filters, for of the 41 samples of effluent of Filter No. 3 B that contained *B. coli*, 34, or 83 per cent., were collected in January, February, March, November and December; and of the 14 samples of effluent of Filter No. 8 A that contained *B. coli*, 11, or 79 per cent., were collected in these months.

Comparison of Tests for B. Coli in One Hundred Cubic Centimeters and One Cubic Centimeter of Filtered Water.

In the report of the Board for last year the statement was made that "The volume of water to be tested for *B. coli* has been an object for special study at the station, as it is evident that we are more likely to find the germ in 100 cubic centimeters or 50 cubic centi-

meters of water than in 1 cubic centimeter. Following out this line of thought the question arises, when filtering a water as polluted as that of the Merrimack River, is a degree of filtration that eliminates *B. coli* from the water essential in order to feel sure that all disease germs are eliminated, or is it only necessary that the filtration shall be so effective that this germ is not found, or but seldom found, in 1 cubic centimeter of the water examined?" A large amount of work has been done along this line of study during 1900, and it is summarized in the following tables, showing the results of a large number of tests for *B. coli* in 100 and 1 cubic centimeters of the effluents from our various experimental filters at the station and the effluent of the Lawrence city filter.

Daily Tests for B. Coli in One and One Hundred Cubic Centimeters of the Effluent of Filter No. 3B — 1900.

Day of Month.	Jan. 1 C.C.	Jan. 100 C.C.	Feb. 1 C.C.	Feb. 100 C.C.	Mar. 1 C.C.	Apr. 1 C.C.	Apr. 100 C.C.	May. 1 C.C.	May. 100 C.C.	June. 1 C.C.	June. 100 C.C.	July. 1 C.C.	July. 100 C.C.	Aug. 1 C.C.	Aug. 100 C.C.	Sept. 1 C.C.	Sept. 100 C.C.	Oct. 1 C.C.	Oct. 100 C.C.	Nov. 1 C.C.	Nov. 100 C.C.	Dec. 1 C.C.	Dec. 100 C.C.
1, . .	0	+	+	+	-	-	-	-	-	0	0	-	-	0	0	0	-	0	0	0	0	+	-
2, . .	+	+	+	+	-	0	-	-	-	0	-	0	-	0	0	-	-	0	0	0	0	-	-
3, . .	0	+	+	-	-	0	0	-	-	-	-	0	-	0	0	-	-	0	0	0	-	0	0
4, . .	+	+	-	-	-	0	0	-	-	0	0	-	-	0	-	0	0	0	0	-	-	0	0
5, . .	+	+	0	-	-	0	0	-	-	0	0	0	0	-	-	0	+	0	-	0	0	0	+
6, . .	+	-	0	+	-	0	0	-	-	0	0	0	0	0	0	0	0	0	-	0	0	0	+
7, . .	-	-	0	+	-	0	-	-	-	0	0	0	0	0	0	0	0	-	-	0	0	0	+
8, . .	+	+	+	+	+	-	-	-	-	0	0	-	-	0	0	0	-	0	0	0	0	+	-
9, . .	0	0	+	+	0	0	0	-	-	0	-	0	-	0	0	-	-	0	0	0	0	-	-
10, . .	0	+	0	-	0	0	0	-	-	-	-	0	0	0	0	0	0	0	0	0	-	+	+
11, . .	+	+	-	-	-	0	0	+	+	0	0	0	0	0	-	0	0	0	0	-	-	+	+
12, . .	+	+	0	0	+	0	0	+	-	0	-	0	0	-	-	0	0	0	0	0	0	+	+
13, . .	0	-	0	-	0	0	0	-	-	0	0	-	-	0	-	0	-	0	-	0	0	+	+
14, . .	-	-	-	-	0	0	0	+	+	-	-	-	-	0	0	0	-	-	-	0	0	0	0
15, . .	+	+	-	-	0	-	-	0	0	-	-	-	-	0	0	0	-	0	0	0	0	0	-
16, . .	+	+	-	-	0	0	0	0	+	0	-	0	0	0	0	-	-	0	0	0	+	-	-
17, . .	0	+	-	-	0	0	0	0	+	-	-	0	0	0	-	0	0	0	0	+	-	0	+
18, . .	+	+	-	-	-	0	+	0	0	-	-	0	-	0	-	0	0	0	0	-	-	0	+
19, . .	+	+	-	-	0	-	-	0	-	0	0	0	-	-	-	0	0	0	0	+	+	0	+
20, . .	0	-	+	-	0	0	-	-	-	0	0	+	-	0	-	+	0	0	-	0	0	0	+
21, . .	-	-	0	-	0	-	-	0	0	0	-	0	-	+	-	0	0	-	-	0	0	+	+
22, . .	0	+	-	-	-	-	-	0	0	0	0	-	-	0	0	0	-	0	0	0	0	0	-
23, . .	0	+	0	-	-	-	-	0	0	0	-	0	0	0	+	-	-	0	0	0	-	-	-
24, . .	0	+	0	-	-	-	-	0	0	-	-	0	0	+	+	0	0	0	0	0	-	0	0
25, . .	0	+	-	-	-	-	-	0	0	0	0	0	0	0	-	0	0	0	0	-	-	-	-
26, . .	0	0	-	-	+	-	-	0	-	0	-	0	0	-	-	0	0	0	0	0	0	0	+
27, . .	0	-	-	-	+	0	-	-	-	0	0	0	0	0	0	0	0	0	-	0	0	+	+
28, . .	-	-	-	-	0	-	-	0	0	0	-	0	-	0	0	0	0	0	-	+	-	+	+
29, . .	0	+	-	-	0	-	-	0	0	0	0	-	-	0	0	0	-	-	0	-	-	0	-
30, . .	0	+	-	-	0	-	-	-	-	0	-	0	0	0	0	-	-	0	0	0	0	-	-
31, . .	+	+	-	-	0	-	-	0	+	-	-	0	0	0	+	-	-	0	0	-	-	0	0
Totals, .	27	23	15	7	18	17	13	17	14	23	14	23	15	27	19	24	17	27	22	25	19	25	20
Times found,	12	21	6	6	4	0	1	3	5	0	0	1	0	2	3	1	1	0	0	3	2	9	15

Daily Tests for B. Coli in One and One Hundred Cubic Centimeters of the Effluent of Filter No. 8A — 1900.

Day of Month.	Jan.		Feb.		Mar.	Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.	
	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.
1, . .	0	+	0	+	-	-	-	+	+	0	0	-	-	0	0	0	-	0	0	0	0	0	-
2, . .	0	+	0	+	-	0	-	0	0	0	-	0	-	0	0	-	-	0	0	0	0	-	-
3, . .	+	+	0	-	-	0	0	0	0	-	-	0	-	0	0	-	-	-	-	0	-	0	0
4, . .	0	+	-	-	-	0	0	0	0	0	0	-	-	0	-	0	0	0	0	-	-	0	0
5, . .	+	+	0	0	-	0	0	0	-	0	0	0	0	-	-	0	0	0	0	0	0	0	0
6, . .	0	-	0	0	-	0	0	-	-	0	0	0	0	0	0	0	0	0	-	0	0	0	+
7, . .	-	-	0	0	-	0	-	0	0	0	0	+	-	0	0	0	0	-	-	0	0	+	+
8, . .	0	+	0	+	-	-	-	0	0	0	0	-	-	0	0	0	-	0	0	0	0	0	-
9, . .	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	-	-	0	0	0	0	-	-
10, . .	0	+	0	-	0	0	0	0	0	-	-	0	0	0	0	0	0	0	0	0	-	0	+
11, . .	0	+	-	-	-	0	0	0	0	0	0	0	0	0	-	0	0	0	0	-	-	0	0
12, . .	0	0	0	0	+	0	0	0	-	0	-	0	0	-	-	0	0	0	0	0	0	0	+
13, . .	+	-	0	-	0	0	0	-	-	0	+	0	-	0	-	0	0	0	-	0	0	0	+
14, . .	-	-	-	-	0	0	0	0	0	-	-	0	-	0	0	0	-	-	-	0	0	0	0
15, . .	0	+	-	-	0	-	-	0	0	-	-	-	-	0	0	0	-	0	0	0	0	+	-
16, . .	-	-	-	-	0	0	0	0	0	0	-	0	0	0	0	-	-	0	0	0	0	-	-
17, . .	-	-	-	-	+	0	0	0	0	-	-	0	-	0	-	0	0	0	0	0	-	0	0
18, . .	+	+	-	-	-	0	0	0	0	-	-	0	0	0	-	0	0	0	0	-	-	0	+
19, . .	0	+	-	-	0	-	-	0	-	0	0	0	0	-	-	0	0	0	0	0	0	+	+
20, . .	+	-	-	-	0	0	-	-	-	0	0	0	0	0	-	0	0	0	-	0	0	0	0
21, . .	-	-	0	-	0	-	-	0	0	0	-	0	-	0	-	0	0	-	-	0	0	0	+
22, . .	0	+	-	-	-	-	-	0	0	0	0	-	-	0	0	0	-	0	0	0	0	0	-
23, . .	0	+	0	-	-	-	-	0	0	0	-	0	0	0	+	-	-	0	0	0	-	-	-
24, . .	0	0	0	-	-	-	-	0	0	-	-	0	0	0	0	0	0	0	0	+	-	0	0
25, . .	0	+	-	-	-	-	-	0	0	0	0	0	0	0	-	0	0	0	0	-	-	-	-
26, . .	0	0	-	-	0	-	-	0	-	0	-	0	0	-	-	0	0	0	0	0	0	0	0
27, . .	0	-	-	-	0	0	-	-	-	0	0	0	0	0	-	0	0	0	-	0	0	0	0
28, . .	-	-	-	-	0	0	-	0	0	0	-	0	-	0	-	0	0	-	-	0	0	0	+
29, . .	0	+	-	-	0	-	-	0	0	0	0	-	-	0	-	0	-	0	0	-	-	0	-
30, . .	0	-	-	-	-	0	0	-	-	0	-	0	0	+	+	-	-	0	0	0	0	-	-
31, . .	0	+	-	-	0	-	-	0	0	-	-	0	0	0	+	-	-	0	0	-	-	0	0
Totals, .	25	20	14	8	16	19	14	26	22	23	14	25	17	27	16	24	18	26	22	25	20	25	20
Times found,	5	16	0	3	2	0	0	1	1	0	1	1	0	1	3	0	0	0	0	1	0	3	9

Daily Tests for B. Coli in One and One Hundred Cubic Centimeters of the Effluent of the Lawrence City Filter — 1900.

Day of Month.	Jan.		Feb.		Mar.	Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.	
	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.
1, . .	0	0	0	+	0	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	-
2, . .	+	+	0	+	0	0	-	-	-	+	+	0	0	-	-	-	-	0	0	0	0	-	-
3, . .	0	+	0	-	0	0	0	-	-	0	0	-	-	-	-	-	-	0	0	0	-	0	0
4, . .	0	+	-	-	-	0	0	-	-	0	+	-	-	-	-	0	0	0	0	-	-	+	+
5, . .	0	0	0	+	0	0	0	-	-	0	+	-	-	-	-	-	-	0	0	0	0	0	+
6, . .	0	-	+	+	0	0	0	-	-	0	-	-	-	0	0	-	-	0	-	0	0	+	+
7, . .	-	-	0	+	0	0	-	0	0	-	-	-	-	-	-	-	-	-	-	0	0	0	+
8, . .	0	0	+	+	0	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	-	-
9, . .	0	0	0	0	+	0	0	-	-	-	-	0	+	-	-	-	-	-	-	0	0	-	-
10, . .	0	+	0	-	0	0	0	-	-	+	+	-	-	-	-	-	-	-	-	0	-	+	+
11, . .	0	+	-	-	-	0	0	-	-	+	+	-	-	-	-	0	0	-	-	-	-	+	+
12, . .	+	+	0	0	+	0	0	-	-	0	0	-	-	-	-	-	-	-	-	0	0	0	0
13, . .	+	-	0	+	0	0	0	-	-	+	+	-	-	-	-	-	-	-	-	0	0	0	0
14, . .	-	-	-	-	0	0	0	0	0	0	+	-	-	-	-	-	-	-	-	0	0	0	0
15, . .	+	+	-	-	0	-	-	-	-	0	+	-	-	+	+	-	-	0	0	+	+	0	-
16, . .	+	+	-	-	0	0	0	-	-	0	-	0	0	-	-	-	-	-	-	+	+	-	-
17, . .	0	+	-	-	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	0
18, . .	+	+	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	+
19, . .	+	+	0	-	0	-	-	-	-	0	0	-	-	-	-	0	0	-	-	0	0	0	0
20, . .	+	-	0	-	0	0	0	-	-	0	-	-	-	-	-	-	-	-	-	0	0	+	+
21, . .	-	-	0	-	0	0	0	+	+	0	0	-	-	-	-	-	-	-	-	0	0	+	+
22, . .	+	+	-	-	0	-	-	0	+	0	-	-	-	0	0	-	-	0	0	0	0	+	-
23, . .	+	+	0	-	0	0	0	+	+	0	-	0	0	0	0	-	-	-	-	0	0	-	-
24, . .	+	+	0	-	0	0	0	+	+	-	-	-	-	-	-	0	0	-	-	+	-	0	-
25, . .	0	+	-	-	-	0	0	0	+	0	0	-	-	-	-	-	-	-	-	-	-	-	-
26, . .	0	0	0	-	0	0	0	+	-	0	0	-	-	-	-	-	-	-	-	0	0	0	0
27, . .	0	-	0	-	-	0	-	-	-	0	0	-	-	-	-	+	-	-	-	0	0	+	+
28, . .	-	-	0	-	0	0	-	0	0	0	-	-	-	0	0	0	0	-	-	0	0	0	+
29, . .	0	+	-	-	0	-	-	0	0	0	0	-	-	-	-	0	-	0	0	-	-	+	-
30, . .	0	+	-	-	0	0	0	-	-	0	-	-	-	-	-	-	-	-	-	0	0	-	-
31, . .	0	+	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
Totals, .	27	23	19	9	26	24	19	10	9	23	16	4	4	5	5	7	5	10	9	25	21	24	19
Times found,	11	18	2	7	2	0	0	4	5	4	8	0	1	1	1	1	0	0	0	3	2	9	11

Daily Tests for B. Coli in One and One Hundred Cubic Centimeters of the Filtered Water from the Outlet of the Distributing Reservoir.

Day of Month.	Jan.		Feb.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.	
	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.
1,	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	-
2,	0	-	0	-	0	0	-	-	-	-	0	0	-	-	-	-	0	0	0	0	-	-
3,	0	+	0	-	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	-	0	0
4,	0	-	-	-	0	-	-	-	0	0	-	-	-	-	0	0	0	0	-	-	0	0
5,	0	-	0	-	0	-	-	-	0	0	-	-	-	-	-	-	0	0	0	0	0	+
6,	0	-	0	+	0	-	-	-	0	+	-	-	0	0	-	-	0	-	0	0	0	+
7,	-	-	0	-	0	-	0	0	0	0	-	-	-	-	-	-	-	-	0	0	0	+
8,	0	-	0	-	-	-	-	-	0	0	-	-	-	-	-	-	0	0	0	0	-	-
9,	0	-	0	-	0	0	-	-	0	-	0	0	-	-	-	-	-	-	0	0	-	-
10,	0	+	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	+
11,	0	-	-	-	0	-	-	-	0	+	-	-	-	-	-	-	-	-	-	-	+	+
12,	+	-	0	+	0	-	-	-	0	0	-	-	-	-	0	0	-	-	0	0	0	0
13,	0	-	0	-	0	-	-	-	+	+	-	-	-	-	-	-	-	-	0	0	+	+
14,	-	-	-	-	0	-	0	0	0	+	-	-	-	-	-	-	-	-	0	0	0	+
15,	+	+	-	-	-	-	-	-	0	0	-	-	0	0	-	-	0	0	0	+	+	-
16,	0	-	-	-	0	0	-	-	0	0	0	0	-	-	-	-	-	-	0	0	-	-
17,	+	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	0	0
18,	+	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
19,	+	-	0	-	-	-	-	-	0	0	-	-	-	-	0	0	-	-	0	0	0	0
20,	0	-	0	-	0	-	-	-	0	0	-	-	-	-	-	-	-	-	0	+	0	0
21,	-	-	0	-	0	-	0	0	0	-	-	-	-	-	-	-	-	-	0	0	0	0
22,	0	+	-	-	-	-	0	0	0	0	-	-	0	0	-	-	0	0	0	0	0	-
23,	+	-	0	-	0	0	0	0	0	-	0	0	-	-	-	-	-	-	0	+	-	-
24,	+	-	0	-	0	-	0	0	-	-	-	-	-	-	0	0	-	-	+	-	0	-
25,	0	-	-	-	0	-	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-
26,	0	-	-	-	0	-	0	-	0	0	-	-	-	-	-	-	-	-	0	0	0	+
27,	+	-	-	-	0	-	-	-	0	0	-	-	-	-	0	0	-	-	0	0	0	+
28,	-	-	-	-	0	-	0	0	0	-	-	-	0	0	0	0	-	-	0	0	0	0
29,	0	+	-	-	-	-	0	0	0	0	-	-	-	-	0	-	0	0	-	-	0	-
30,	0	-	-	-	0	0	-	-	0	-	-	-	-	-	-	-	-	-	+	+	-	-
31,	0	-	-	-	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-	-	0	0
Totals,	27	5	16	2	24	5	10	9	23	18	5	5	4	4	7	6	10	9	25	21	24	19
Times found,	8	5	0	2	0	0	0	0	1	4	0	0	0	0	0	0	0	0	3	4	3	9

Daily Tests for B. Coli in One and One Hundred Cubic Centimeters of the Filtered Water from a Tap at the City Hall.

Day of Month.	Jan.		Feb.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.	
	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.
1,	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	-
2,	0	-	0	-	0	0	-	-	-	-	0	0	-	-	-	-	0	0	0	0	-	-
3,	0	+	0	-	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	-	0	0
4,	0	-	-	-	0	-	-	-	0	0	-	-	-	-	0	0	0	0	-	-	0	0
5,	0	-	0	-	0	-	-	-	0	0	-	-	-	-	-	-	0	0	0	0	0	0
6,	0	-	0	+	0	-	-	-	0	0	-	-	0	0	-	-	0	-	0	0	0	0
7,	-	-	0	-	0	-	0	0	0	0	-	-	-	-	-	-	-	-	0	0	0	0
8,	0	-	0	-	-	-	-	-	0	0	-	-	-	-	-	-	0	0	0	0	-	-
9,	0	-	0	-	0	0	-	-	0	-	0	+	-	-	-	-	-	-	0	0	-	-
10,	0	+	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	0
11,	0	-	-	-	0	-	-	-	0	+	-	-	-	-	0	0	-	-	-	-	0	0
12,	0	-	0	+	0	-	-	-	0	0	-	-	-	-	-	-	-	-	0	0	0	0
13,	0	-	0	-	0	-	-	-	0	+	-	-	-	-	-	-	-	-	0	0	0	+
14,	-	-	-	-	0	-	0	0	0	0	-	-	-	-	-	-	-	-	0	0	+	+
15,	+	+	-	-	-	-	-	-	0	0	-	-	0	0	-	-	0	0	0	0	0	-
16,	0	-	-	-	0	0	-	-	0	-	0	0	-	-	-	-	-	-	0	0	-	-
17,	+	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	0
18,	0	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
19,	+	-	0	-	-	-	-	-	0	0	-	-	-	-	0	0	-	-	0	0	0	0
20,	0	-	0	-	0	-	-	-	0	0	-	-	-	-	-	-	-	-	0	0	0	+
21,	-	-	0	-	0	-	0	0	0	-	-	-	-	-	-	-	-	-	0	0	0	0
22,	0	+	-	-	-	-	0	0	0	0	-	-	0	0	-	-	0	0	0	0	0	-
23,	+	-	-	-	0	0	0	0	0	-	0	0	-	-	-	-	-	-	0	-	-	-
24,	0	-	-	-	0	-	0	0	-	-	-	-	-	-	0	0	-	-	-	-	0	-
25,	0	-	-	-	0	-	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-
26,	0	-	-	-	0	-	0	-	0	0	-	-	-	-	-	-	-	-	0	0	0	0
27,	0	-	-	-	0	-	-	-	0	0	-	-	0	0	0	0	-	-	0	0	0	+
28,	-	-	-	-	0	-	0	0	0	0	-	-	-	-	0	0	-	-	0	0	+	+
29,	0	+	-	-	-	-	0	0	0	0	-	-	-	-	0	-	0	0	-	-	0	-
30,	0	-	-	-	0	0	-	-	0	-	-	-	-	-	-	-	-	-	0	0	-	-
31,	0	-	-	-	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-	-	0	0
Totals,	27	5	14	2	24	5	10	9	23	18	5	5	4	4	7	6	10	9	24	20	24	19
Times found,	4	5	0	2	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	3	6

Daily Tests for B. Coli in One and One Hundred Cubic Centimeters of the Filtered Water from a Tap at the Experiment Station.

Day of Month.	Jan.		Feb.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.	
	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.	1 C. C.	100 C. C.
1, ...	0	-	0	-	-	-	0	-	0	0	-	-	0	-	0	-	0	+	0	0	0	0
2, ...	0	-	0	-	0	0	0	-	0	-	0	-	0	-	-	-	0	0	0	0	-	-
3, ...	0	+	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	0	0	-	0	0
4, ...	0	-	-	-	0	-	0	-	0	0	-	-	0	-	0	0	0	0	-	-	0	0
5, ...	0	-	0	-	0	-	0	-	0	0	0	-	-	-	0	-	0	0	0	0	0	0
6, ...	0	-	0	+	0	-	-	-	0	0	0	-	0	0	0	-	0	-	0	0	0	+
7, ...	-	-	0	-	0	-	0	0	0	0	0	-	0	-	0	-	-	-	0	0	0	0
8, ...	0	-	0	-	-	-	0	-	0	0	-	-	0	-	0	-	0	0	0	0	0	-
9, ...	0	-	0	-	0	0	0	-	0	-	0	0	0	-	-	-	0	-	0	0	-	-
10, ...	0	+	0	-	0	-	0	-	-	-	0	-	0	-	0	-	0	-	0	-	0	+
11, ...	0	-	-	-	0	-	0	-	0	0	0	-	0	-	0	0	0	-	-	-	0	0
12, ...	0	-	0	0	0	-	0	-	0	0	0	-	-	-	0	-	0	-	0	0	0	+
13, ...	0	-	0	-	0	-	-	-	0	+	0	-	0	-	0	-	0	-	0	0	0	0
14, ...	-	-	-	-	0	-	0	0	0	0	0	-	0	-	0	-	-	-	0	0	0	0
15, ...	0	+	-	-	-	-	0	-	-	-	-	-	0	-	0	-	0	0	0	0	-	-
16, ...	+	-	-	-	0	0	0	-	0	-	0	0	0	+	-	-	0	-	0	0	-	-
17, ...	+	-	-	-	0	-	0	-	-	-	0	-	0	-	0	-	0	-	0	-	0	0
18, ...	0	-	-	-	0	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	0	0
19, ...	0	-	0	-	-	-	0	-	0	0	0	-	-	-	0	-	0	-	0	0	+	+
20, ...	0	-	0	-	0	-	-	-	0	0	0	-	0	-	0	-	0	-	0	0	0	+
21, ...	-	-	0	-	0	-	0	0	0	-	0	-	0	-	0	-	-	-	0	0	0	0
22, ...	0	+	-	-	-	-	0	0	0	0	-	-	0	0	0	-	0	0	0	0	0	-
23, ...	0	-	-	-	0	0	0	0	0	-	0	0	0	-	-	-	0	-	0	-	-	-
24, ...	0	-	-	-	0	-	0	0	-	-	0	-	0	-	0	0	0	-	+	-	+	-
25, ...	0	-	-	-	0	-	0	0	0	0	0	-	0	-	0	0	0	-	-	-	-	-
26, ...	0	-	-	-	0	-	0	-	0	0	0	-	-	-	0	+	0	-	0	0	0	+
27, ...	0	-	-	-	0	-	-	-	0	-	0	-	0	0	0	0	0	-	0	0	0	+
28, ...	-	-	-	-	0	-	0	0	0	-	0	-	0	-	0	0	-	-	0	0	0	0
29, ...	0	0	-	-	-	-	0	0	0	0	-	-	0	-	0	-	0	0	-	-	0	-
30, ...	0	-	-	-	0	0	-	-	0	-	0	-	0	-	-	-	0	-	0	0	-	-
31, ...	0	-	-	-	-	-	0	0	-	-	0	0	0	-	-	-	0	-	-	-	0	0
Totals, . .	27	5	14	2	24	5	26	10	24	16	25	4	27	4	24	8	27	9	25	20	24	20
Times found, . .	2	4	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0	1	1	0	2	7

Summary of B. Coli Tests on the Water applied to and Effluents

	1900.	Canal Water. Number of Samples Tested.	Canal Water. Number of Times B. Coli found.	Canal Water. Average Number of B. Coli per Cubic Centimeter.	Canal Water. Per Cent. of Samples Containing B. Coli.	Filter 3 B. Number of Samples Tested.	Filter 3 B. Number of Times B. Coli found.	Filter 3 B. Per Cent. of Samples Containing B. Coli.
1	January, . .	27	27	54	100.00	27	12	44.44
2	February, . .	18	18	43	100.00	15	6	40.00
3	March, . .	26	26	20	100.00	18	4	22.22
4	April, . .	19	19	14	100.00	17	0	0.00
5	May, . . .	26	26	40	100.00	17	3	17.65
6	June, . . .	22	22	90	100.00	23	0	0.00
7	July, . . .	25	25	83	100.00	23	1	4.34
8	August, . .	26	26	41	100.00	27	2	7.41
9	September, .	24	24	29	100.00	24	1	4.17
10	October, . .	26	26	30	100.00	27	0	0.00
11	November, .	24	24	77	100.00	25	3	12.00
12	December, .	25	25	69	100.00	25	9	36.00
13	Total, . .	288	288	49	100.00	268	41	15.32

Summary of B. Coli Tests

	1900.	River at Experiment Station. Number of Samples Tested for B. Coli.	River at Experiment Station. Number of Times B. Coli found.	River at Experiment Station. Average Number of B. Coli per Cubic Centimeter.	River at Experiment Station. Per Cent. of Samples Containing B. Coli.	River at Intake of Filter. Number of Samples Tested for B. Coli.	River at Intake of Filter. Number of Times B. Coli found.	River at Intake of Filter. Average Number of B. Coli per Cubic Centimeter.	River at Intake of Filter. Per Cent. of Samples Containing B. Coli.
1	January, ...	26	26	119	100.00	26	26	89	100.00
2	February, ...	11	11	88	100.00	19	19	57	100.00
3	March, ...	0	0	0	100.00	26	25	316	96.15
4	April, ...	0	0	0	100.00	24	24	43	100.00
5	May, ...	0	0	0	100.00	11	11	50	100.00
6	June, ...	4	4	181	100.00	20	20	184	100.00
7	July, ...	0	0	0	100.00	5	5	59	100.00
8	August, ...	0	0	0	100.00	4	4	101	100.00
9	September, ...	4	4	251	100.00	6	6	179	100.00
10	October, ...	3	3	147	100.00	10	10	34	100.00
11	November, ...	5	5	286	100.00	24	24	127	100.00
12	December, ...	9	9	117	100.00	24	24	108	100.00
13	Total, ...	62	62	142	100.00	199	198	87	99.67

from the Experimental Filters (in One Cubic Centimeter).

Filter 8 A.			Filter 142.			Filter 143.			
Number of Samples Tested.	Number of Times B. Coli found.	Per Cent. of Samples Containing B. Coli.	Number of Samples Tested.	Number of Times B. Coli found.	Per Cent. of Samples Containing B. Coli.	Number of Samples Tested.	Number of Times B. Coli found.	Per Cent. of Samples Containing B. Coli.	
25	5	20.00	-	-	-	-	-	-	1
14	0	0.00	-	-	-	-	-	-	2
16	2	12.50	-	-	-	-	-	-	3
19	0	0.00	-	-	-	-	-	-	4
26	1	3.85	-	-	-	-	-	-	5
23	0	0.00	11	0	0.00	11	0	0.00	6
25	1	4.00	22	5	22.73	21	2	8.70	7
27	1	3.70	26	3	11.54	27	4	14.81	8
24	0	0.00	24	0	0.00	24	3	12.50	9
26	0	0.00	26	0	0.00	26	1	3.85	10
25	1	4.00	24	5	20.83	24	5	20.83	11
25	3	12.00	24	9	3.75	25	5	20.00	12
275	14	5.09	157	19	12.10	158	20	12.66	13

(in One Cubic Centimeter).

Effluent of City Filter.			Outlet of Reservoir.			Tap at City Hall.			Tap at Experiment Station.			
Number of Samples Tested for B. Coli.	Number of Times B. Coli found.	Per Cent. of Samples Containing B. Coli.	Number of Samples Tested for B. Coli.	Number of Times B. Coli found.	Per Cent. of Samples Containing B. Coli.	Number of Samples Tested for B. Coli.	Number of Times B. Coli found.	Per Cent. of Samples Containing B. Coli.	Number of Samples Tested for B. Coli.	Number of Times B. Coli found.	Per Cent. of Samples Containing B. Coli.	
27	11	40.74	27	8	29.63	27	4	14.82	27	2	7.40	1
19	2	10.53	16	0	0.00	14	0	0.00	14	0	0.00	2
26	2	7.69	-	-	-	-	-	-	-	-	-	3
24	0	0.00	24	0	0.00	24	0	0.00	24	0	0.00	4
10	4	40.00	10	0	0.00	10	0	0.00	26	0	0.00	5
23	4	17.35	23	1	4.35	23	0	0.00	24	0	0.00	6
4	0	0.00	5	0	0.00	5	0	0.00	25	0	0.00	7
5	1	20.00	4	0	0.00	4	0	0.00	27	0	0.00	8
7	1	14.29	7	0	0.00	7	0	0.00	24	0	0.00	9
10	0	0.00	10	0	0.00	10	0	0.00	27	0	0.00	10
25	3	12.00	25	3	12.00	24	0	0.00	25	1	4.00	11
24	9	37.50	24	3	12.50	24	3	12.50	24	2	8.33	12
204	37	18.14	175	15	8.57	172	7	4.07	267	5	1.87	13

Summary of B. Coli Tests (in

	1900.	Filter 3B.			Filter 8A.			Effluent of City Filter.		
		Number of Samples Tested.	Number of Times B. Coli found.	Per Cent. of Samples Containing B. Coli.	Number of Samples Tested.	Number of Times B. Coli found.	Per Cent. of Samples Containing B. Coli.	Number of Samples Tested.	Number of Times B. Coli found.	Per Cent. of Samples Containing B. Coli.
1	January, .	23	21	91.30	20	16	80.00	23	18	78.26
2	February, .	7	6	85.71	8	3	37.50	9	7	77.78
3	March, .	-	-	-	-	-	-	-	-	-
4	April, . .	13	1	7.69	14	0	0.00	19	0	0.00
5	May, . .	14	5	35.91	22	1	4.55	9	5	55.56
6	June, . .	14	0	0.00	14	1	7.14	16	8	50.00
7	July, . .	15	0	0.00	17	0	0.00	4	1	25.00
8	August, .	19	3	15.79	16	3	18.75	5	1	20.00
9	September, .	17	1	5.88	18	0	0.00	5	0	0.00
10	October, .	22	0	0.00	22	0	0.00	9	0	0.00
11	November, .	19	2	10.53	20	0	0.00	21	2	9.52
12	December, .	20	15	75.00	20	9	45.00	19	11	57.89
13	Total, .	183	54	29.51	191	33	17.28	139	53	38.12

The last two tables give the various results from the raw and filtered water in detail, but so gathered as to make clear the work of each filter in removing *B. coli* and the variation in number found from month to month during the year. Studying these results and comparing them we find that, of the 1,676 samples of filtered water tested for *B. coli* with 1 cubic centimeter, in 159, or 9.5 per cent. of the total number, was the germ found, and of the 822 duplicate samples of filtered water tested for *B. coli* with 100 cubic centimeters, in 196, or 23.9 per cent. of the total number, was the germ found. Comparing the tables further we see that a large proportion of the samples in which *B. coli* was found in testing with 100 cubic centimeters and not found when testing with 1 cubic centimeter was of effluents collected during the colder months of the year. For example, the effluent of Filter No. 3 B in January and February showed when examining 1 cubic centimeter the presence of *B. coli* in 44 and 40 per cent. of the samples tested respectively, but when testing with 100 cubic centimeters it was found in 91 and 86 per cent. of the samples respectively. The effluent of Filter No. 8 A when examined during these two months showed *B. coli* in 20 and 00 per cent. respectively of the 1 cubic cen-

One Hundred Cubic Centimeters).

Outlet of Reservoir.			Tap at City Hall.			Tap at Experiment Station.			
Number of Samples Tested.	Number of Times B. Coli found.	Per Cent. of Samples Containing B. Coli.	Number of Samples Tested.	Number of Times B. Coli found.	Per Cent. of Samples Containing B. Coli.	Number of Samples Tested.	Number of Times B. Coli found.	Per Cent. of Samples Containing B. Coli.	
5	5	100.00	5	5	100.00	5	4	80.00	1
2	2	100.00	2	2	100.00	2	1	50.00	2
-	-	-	-	-	-	-	-	-	3
5	0	0.00	5	0	0.00	5	0	0.00	4
9	0	0.00	9	0	0.00	10	0	0.00	5
18	4	22.22	18	2	11.11	16	1	6.25	6
5	0	0.00	5	1	20.00	4	0	0.00	7
4	0	0.00	5	0	0.00	4	1	25.00	8
6	0	0.00	6	0	0.00	8	1	12.50	9
9	0	0.00	9	0	0.00	9	1	11.11	10
21	4	19.05	20	0	0.00	20	0	0.00	11
19	9	47.37	19	6	31.58	20	7	35.00	12
103	24	23.30	103	16	15.54	103	16	15.54	13

timeter samples, and in 80 and 37 per cent. respectively of the 100 cubic centimeter samples. The same proportion holds true practically with the other effluents tested in these months and in the month of December, 1900, but in the warmer months of the year very few samples in which *B. coli* was not detected when testing 1 cubic centimeter showed the germ present when testing 100 cubic centimeters.

The first table, giving the *B. coli* results of a series of samples of Lawrence city water, shows, as we should expect, a regular and comparatively rapid decrease of the germ in this filtered water during the time taken for it to pass through the distribution system. This table also shows that the number of *B. coli* per cubic centimeter in the Merrimack River water doubles after the entrance into the river of a considerable portion of the sewage of Lawrence, as noted by the tests made with samples of water from the intake of the city filter above Lawrence and samples from the river at the experiment station below Lawrence. The results showing the number in the river water indicate that more are found in the river at Lawrence in the winter than in the summer, this being due principally to the low temperature of the water reducing bacterial activity, and partly also to the greater

flow of water generally occurring in the winter, which causes the time of passage of sewage to Lawrence from sewers at Lowell and other cities on the river to be less in winter than in summer, both factors impeding the destruction of bacteria in the water by natural causes.

The tabulated tests show that *B. coli* was often found on successive days in the large volume, whenever it proved to be present in 1 cubic centimeter in one or more samples during a week's tests. In other words, although positive tests were not found consecutively on one cubic centimeter, yet, when these positive tests were found at short intervals, the tests in the larger volume showed the organism to be present generally on the intermediate days when the 1 cubic centimeter tests were negative. If, however, the tests in 1 cubic centimeter were consecutively negative for any considerable number of days, the tests in 100 cubic centimeters were also negative. Only in a very few instances was a positive test found in 100 cubic centimeters which would not have been expected from the 1 cubic centimeter results.

Relation of the Presence of B. Coli in Filtered Water to the Healthfulness of the Water.

It was stated when these investigations upon the passage of *B. coli* through sand filters were begun that this line of work at Lawrence was thought to be especially valuable, for several reasons. If *B. coli* should be found in a public water supply which had not undergone filtration, it would be considered that there had been a direct contamination of the water, and, if the water was not filtered, there would be danger that typhoid germs associated with the *B. coli* would reach the consumers of this unfiltered water. At Lawrence, however, we have a water which is known to be badly polluted filtered, and, owing to the large numbers of *B. coli* in a polluted water such as that of the Merrimack River compared with the number of typhoid germs that can possibly be present even at times of a severe epidemic of typhoid fever, it was regarded as questionable whether a degree of filtration that would eliminate all the *B. coli* was necessary. The impossibility of determining the percentage removal by filters of the germs of typhoid fever in the Merrimack River water as it reaches Lawrence is, of course, apparent, but a study of the efficiency of water filters in removing *B. coli*, a close prototype of *B. typhosus*, was, it seemed, possible

and of considerable significance. We had been studying for several years the work of sand filters of various kinds, and operated at various rates, in respect to their power to remove from the river water a large percentage of all the bacteria contained in it, and expecting that the filtered water would have in the neighborhood of 1 per cent. of the total number of bacteria in the unfiltered water; assuming that with a degree of efficiency equal to this the few typhoid germs present in the raw water were being efficiently removed. Whether some bacteria naturally present in the water were more easily eliminated by filtration than others was not known with a certainty that direct tests and determinations give, although the facts in favor of the presumption that this was true were more or less convincing.

The question arose, then, while we must have efficient hygienic filtration when supplying a city with a polluted water filtered, can we not better judge when this is attained by a study of the removal of *B. coli* by the filter than by a study of the total number of bacteria of all kinds removed, and is the removal of all *B. coli* by a sand filter an unnecessary degree of bacterial refinement in the filtration of a water polluted as badly as that flowing in the Merrimack River at Lawrence? That this is so seems true when we consider that there are on the near water-shed of the Merrimack River above Lawrence approximately 200,000 people whose sewage enters the river, nearly one-half of these being within eight miles of the intake of the city filter, and yet the number of *B. coli* in the river water at this intake averaged during 1900 only 87 per cubic centimeter. We know, then, how few the germs of typhoid fever per cubic centimeter in the water at this point must be compared with the number of *B. coli* germs, even if several hundred people above Lawrence were ill with this disease at one time, — a very unusual occurrence, — and how slight their liability of passing through the filter must be when so few, as our studies have shown, of the hardier *colon bacilli* are able to survive until they reach the underdrains.

Comparing now the *B. coli* tests during the year 1900 of samples of the Lawrence water supply with the cases and deaths from typhoid fever in the city, and also comparing the cases and deaths from the same cause in two cities of the State having almost exactly the same population as Lawrence, but one of which receives the exceedingly satisfactory water supply of the metropolitan district and the other

a water supply from a practically unpolluted source not filtered, we find the following facts: —

In Lawrence there were 77 cases of typhoid fever during the year and 9 deaths, 5 of these deaths, however, being of operatives in one of the mills of the city which is piped with unfiltered river water which many of the operatives drink, — many of the cases in this and the other mills of the city undoubtedly being due to drinking the same unfiltered water, — and 2 of the deaths being of people who came to the city ill with the disease. In the city which is supplied with metropolitan water there were 73 cases during the year and 7 deaths, and in the city supplied with another surface water from a practically unpolluted source and not filtered there were 68 cases and 15 deaths. In all of these cities there is a considerable spring-water trade. While, of course, this relation of these cities one to the other in this respect would vary from year to year, and figures in regard to typhoid fever and the reduction of death-rates by filtration, etc., can be made by different manipulation to show apparently many things, it seems reasonable to suppose from a comparison of these three cities that the Lawrence city water as supplied to its inhabitants during the year 1900 was not the cause in any instance of typhoid fever, even although 8.57 per cent. of the samples of this water collected at the outlet of the reservoir contained *B. coli* in sufficient numbers to give a positive test when only 1 cubic centimeter was examined.*

Moreover, referring again to the tests for this organism in the filtered water produced by our sand filters when operated at different rates, we find that, while reducing the rates to approximately 1,500,000 caused a considerable decrease in the percentage of samples tested that contained *B. coli*, yet it is not by any means proven that higher rates with a greater percentage of positive tests are dangerous. We should believe from all the knowledge that we have upon the subject that a rate of 2,500,000 gallons per acre daily is safe even when filtering a water as polluted as that of the Merrimack River, but that a rate much greater than this might give an unsafe effluent in winter, when bacterial activity and efficiency are at their lowest point, although perhaps efficient in warm weather. Referring to page 494 of the report of the Board for 1898, it will be seen that a rate of

* There are also two other cities in the State of about the same population as Lawrence and both have surface water supplies not filtered. In one of these cities there were, during 1900, 125 cases of typhoid fever and 22 deaths, and in the other, 46 cases and 13 deaths.

2,500,000 gallons per acre daily gave a much better *B. coli* efficiency during cold weather than a rate of 4,000,000 gallons per acre daily; while a rate of 4,000,000 during warm weather gave a *B. coli* efficiency at least equal to that obtained at a rate of 2,500,000 in winter.

Organisms upon the Surface of Water Filters (Bacterial and Microscopic).

As the elimination of bacteria from water by slow sand filtration is largely a biological process, depending, we have always believed, upon the destruction of bacteria at or near the surface of sand filters by the bacterial organisms in the sand, aided both in their growth or increase in numbers and in their work by gelatinous organic matter strained from the applied water, the comparison of winter and summer results given on previous pages is of interest. The results of a very elaborate investigation* recently published gives credit, however, for practically all the bacterial efficiency of a filter to microscopic organisms upon the surface sand, and states that for this reason uncovered filters, open to the sunlight, are able to give better results than covered filters, because of the more abundant growth of microscopic organisms in or upon the surface sand under these favorable conditions. The idea has also been advanced by the same writer that probably the poor results obtained by the experimental sand filters at Louisville, Kentucky, were due to the fact that the great turbidity of the water so darkened it as to preclude the growth of microscopic organisms upon the sand. Examinations of the results obtained from our experimental filters at Lawrence and the Lawrence city filter, in removing both total numbers of bacteria and *B. coli*, do not seem, however, to uphold this theory. For instance, Filter No. 8 A at the experiment station, which has been for a number of years so covered by a roof of planking and earth that the process of filtration has taken place entirely in the dark, no light being admitted to the chamber over the filter except at times of scraping, gives the best results, all things considered, of any of our filters; and many examinations of the surface sand from the Lawrence city filter and our experimental filters during the past year have shown that, while the greater number of what are classed as microscopic organisms is found upon the sand of the

* By Ad. Kemna, C.E., engineer in charge of the water works of Antwerp, Belgium. "The Surveyor," June, 1899.

open filters, still these organisms are almost entirely those strained out mechanically from the applied water by the filter. They do not die, however, so rapidly in the light as in the dark, and hence we find them present more abundantly upon the sand of the open filters. There are periods in August and September in each year when an abundant growth of *Spirogyra* appears on the surface of our open intermittent filters, but this is practically the only growth of any moment upon the surface, and is there for at most but a few weeks of the year. Very many examinations of the surface sand from the various filters have shown great variations in the number of these organisms, varying from 550 per cubic millimeter to 24,550 in the samples from the Lawrence city filter, from 2,950 to 14,400 in the samples of sand from Filter No. 3 B and from 700 to 3,250 in the samples from Filter No. 8 A.

All our observations at Lawrence go to prove that covered filters are more efficient in the removal of bacteria than open filters, and that the decreased efficiency of the filters in winter is due (1) to the fact that not so large an amount of gelatinous organic matter comes to the filter's surface with the water as in the summer months, this being due to the greater flow generally of water in the river in the winter than in the summer, and hence the purer character of this water from a chemical point of view; and (2) to the fact that bacterial oxidation and the destruction of one species of bacteria by another is retarded by low temperature. That is to say, the biological process upon which efficient filtration with sand filters at Lawrence largely depends is carried on by the bacterial organisms aided by warmth and gelatinous organic matter, rather than by microscopic organisms. The millions of bacteria in the upper layers of sand in our filters are shown by tables given in the early reports from the station.

Filtration of Highly Polluted Water.

Double Filtration.

Filters Nos. 68 and 69 were put into operation May 9, 1896, and were continued in operation until March 31, 1900. They were 20 inches in diameter and contained when started 60 inches in depth of sand of an effective size of 0.23 millimeter. During most of this period one of the filters was operated intermittently and the other continuously, and the results obtained have been elaborated in the

various reports of the Board. It was shown that with the highly polluted water first applied to these filters the intermittent method of operation was necessary in order to obtain satisfactory bacterial and chemical results. With the less polluted water applied during the last two years of their operation, containing enough dissolved oxygen not to become exhausted by the oxidation of organic matters during filtration, continuous filtration was as efficient as intermittent filtration. While the bacterial efficiency of these filters was good during a large part of their period of operation as far as percentage removal of bacteria was concerned, the number of bacteria remaining in their effluents was greater than allowable with sand filtration, this being due to the very large number of bacteria in the water applied to them. Hence, soon after they were put into operation a secondary filter was installed, containing 5 feet in depth of sand of the same effective size as that in the two primary filters, Nos. 68 and 69. This filter was operated in the continuous manner and was kept in operation until the last of January, 1897; but, as stated in previous reports, owing to the fact that most of the gelatinous organic matter had been removed from the water applied to this secondary filter during its primary filtration, only a slight coating was formed upon the sand grains, and, as the sand itself was no finer than that in the primary filters, it was not particularly efficient in removing bacteria.

Upon April 23, 1898, secondary Filter No. 109 was put into operation to receive the effluents of the primary filters in place of the filter just described. This filter contained 4 feet in depth of sand of an effective size of 0.14 millimeter, that is, of a grade much finer than that in the primary filters. To it the entire combined effluents of Filters Nos. 68 and 69 were applied from the date given until March 31, 1900, when all these filters went out of operation. Its rate of operation averaged about 2,500,000 gallons per acre daily.

During the period of seventeen months, from May 19, 1896, when Filters Nos. 68 and 69 were first put in operation, to Oct. 17, 1897, the water applied to them was Merrimack River water with which a certain percentage of sewage had been mixed at the station. During the period of applying this water to the filters Filter No. 68 was scraped nineteen times, while operating at an average rate of practically 1,200,000 gallons per acre daily; and Filter No. 69 was

scraped thirty-four times, while operating at an average rate of about 1,050,000 gallons per acre daily. From Nov. 19, 1897, to Sept. 23, 1899, however, — a period of twenty-two months, — the water applied to these two filters was the filtered river water (Lawrence city supply), to which a certain percentage of sewage was added, and the mixture allowed to stand for sedimentation to take place. Operating with this water, most of which had once passed through a sand filter and had its mineral matter in suspension removed, these two filters did not become clogged at the surface in such a manner as to necessitate scraping during this period of nearly two years; that is to say, the organic matter in the applied water underwent bacterial oxidation and there was very little finely divided mineral matter present to clog the surfaces of the filters.

The three following tables show the bacterial efficiency of these three filters during their period of operation: —

Table showing Efficiency of Filter No. 68 during Different Periods of Operation.

PERIOD.	Method of Operation.	Rate. — Gallons per Acre Daily.	Average Number of Bacteria per Cubic Centimeter in Applied Water.	Average Number of Bacteria per Cubic Centimeter in Effluent.	Bacterial Efficiency (Per Cent.).
Aug. 20, 1896, to Aug. 24, 1897,	Continuous, . .	1,066,000	187,831	7,879	95.81
Aug. 25, 1897, to Oct. 17, 1897,	Intermittent, . .	1,321,000	133,600	4,560	96.59
Oct. 18, 1897, to April 14, 1898,	Intermittent, . .	1,727,000	91,286	394	99.57
April 15, 1898, to May 14, 1898,	Intermittent, . .	2,377,000	19,258	90	99.53
May 15, 1898, to July 17, 1898,	Filter allowed to rest,	-	-	-	-
July 18, 1898, to Nov. 4, 1898,	Intermittent, . .	1,274,000	30,769	173	99.44
Nov. 5, 1898, to March 31, 1900,	Intermittent, . .	1,657,000	42,310	427	98.99

Table showing Efficiency of Filter No. 69 during Different Periods of Operation.

PERIOD.	Method of Operation.	Rate. — Gallons per Acre Daily.	Average Number of Bacteria per Cubic Centimeter in Applied Water.	Average Number of Bacteria per Cubic Centimeter in Effluent.	Bacterial Efficiency (Per Cent.).
Aug. 21, 1896, to Aug. 31, 1896,	Intermittent, . .	964,000	389,778	1,922	99.51
Sept. 1, 1896, to Oct. 17, 1897,	Intermittent, . .	1,144,000	175,728	806	99.54
Oct. 18, 1897, to April 14, 1898,	Intermittent, . .	1,843,000	91,286	281	99.69
April 15, 1898, to June 17, 1898,	Continuous, . .	2,961,000	20,981	177	99.16
June 18, 1898, to Nov. 4, 1898,	Continuous, . .	2,179,000	31,271	150	99.52
Nov. 5, 1898, to March 31, 1900,	Continuous, . .	1,591,000	42,310	401	99.05

Table showing Efficiency of Filter No. 109 during Different Periods of Operation.

Period.	Method of Operation.	Rate. — Gallons per Acre Daily.	Average Number of Bacteria per Cubic Centimeter in Effluent.	Bacterial Efficiency (Per Cent.).
April 23, 1898, to June 9, 1898, ...	Continuous, . .	2,380,000	68	99.52
June 10, 1898, to June 17, 1898, ...	Continuous, . .	2,865,000	23	99.83
June 18, 1898, to July 17, 1898, ...	Continuous, . .	1,925,000	50	99.85
July 18, 1898, to March 31, 1900, ...	Continuous, . .	2,623,000	97	86.84

The Removal of Color from Water by Filtration.

In all of the work at the Lawrence experiment station upon the purification of water by sand filtration, determinations of the color of the water applied to our filters and of the effluents from them have been made. The two largest experimental water filters and the two that have been operated for the longest period are Filters Nos. 3 B (intermittent) and 8 A (continuous), first put into operation in September, 1893. These two filters contained at the time of starting 5 feet in depth of sand of an effective size of 0.24 millimeter. At the end of 1900 there were approximately 27 inches in depth of sand in each filter. The following table gives the average rate of operation of these two filters for each year since they started, together with the average color of the water applied to them and of their effluents for these years. As these filters were in operation only three months during 1893, the averages for that year are omitted from the table.

Year.	Applied Water (Color).	Filter No. 3 B.			Filter No. 8 A.		
		Average Rate of Operation. — Gallons per Acre Daily.	Color.	Per Cent. of Color Removed.	Average Rate of Operation. — Gallons per Acre Daily.	Color.	Per Cent. of Color Removed.
1894, ...	.41	2,451,000	.28	32	2,561,000	.27	34
1895, ...	.46	2,883,000	.32	30	3,378,000	.32	30
1896, ...	.40	2,834,000	.29	28	3,678,000	.29	28
1897, ...	.45	3,276,000	.35	22	4,247,000	.32	29
1898, ...	.45	2,317,000	.29	36	2,662,000	.31	31
1899, ...	.34	2,163,000	.20	41	2,598,000	.22	35
1900, ...	.42	1,548,000	.26	38	1,757,000	.27	36
Average, . .	.42	2,496,000	.28	-	2,983,000	.29	-

It will be noticed that the average color of the river water supplied to these filters for the entire period was .42, the average color of the effluent of Filter No. 3 B was .28, and the average color of the effluent of Filter No. 8 A was .29; these figures showing an average color removal by Filter No. 3 B of 33 per cent. and by Filter No. 8 A of 31 per cent. for the entire period, these averages, however, not showing as great a removal of coloring matter as was the case in some of the different years of this period. For instance, in 1899 Filter No. 3 B removed 41 per cent. of the coloring matter of the water applied to it, and Filter No. 8 A 35 per cent.

The average rainfall per year for this period was as follows: —

YEAR.	Average Rainfall (Inches).	YEAR.	Average Rainfall (Inches).
1894,	39.74	1898,	55.88
1895,	50.62	1899,	37.21
1896,	43.70	1900,	50.66
1897,	46.19		

Studying these two tables we see that there is a general tendency, rate for rate, for the least removal of color by these sand filters in years of high rainfall, when a larger amount of coloring matter extracted from leaves, grass, etc., is washed into the river; and the greatest removal during the years of lowest rainfall, when a larger percentage of the water flowing in the river comes through the ground before reaching it, instead of flowing over the ground, as in times of high rainfall. It is particularly noticeable in studying the results month by month during this period that the smallest percentage of color removal has been in the autumn months of high rainfall. For instance, in October, 1898, the average color of the river water was .64, the average color of the effluent of Filter No. 3 B, .41, and of Filter No. 8 A, .50, the color of the effluents showing an average removal of 36 per cent. of the coloring matter in the applied water by Filter No. 3 B and 22 per cent. by Filter No. 8 A. In July of the same year, however, which was a month practically without rainfall, the color of the river water was .37, the color of the effluent of Filter No. 3 B, .14, and the color of the effluent of Filter No. 8 A, .15, showing a removal of practically 60 per cent. in each in-

stance, the difference in season undoubtedly having some influence, however.

It is also significant that in 1899, when these filters had been in operation six years, the percentage of color removed was as great or greater than in the earlier years of their operation, when the depth of sand was more than twice as great; this being due partly, undoubtedly, to the coating of bacteria and alumina-bearing silt accumulating from year to year upon the sand grains, and partly to the unvarying action of the schmutzdecke, whatever the varying depth of sand in the filter.

These two tables show that the organic coloring matter in water is more easily removed at times of low rainfall, which indicates that the color extracted from what may be called dead vegetable matter, with which the water comes in contact in passing through the ground, is much more easily acted upon in the filter than the coloring matter extracted from what may be called live or dying vegetable matter, such as leaves, grass, etc., with which the water comes in contact when flowing over the surface of the ground.

This question of the removal of color from water supplies is one of considerable importance, as many supplies are of a satisfactory character in every particular with the exception of the high color, which renders them objectionable to the users, and during the last two years considerable special investigation in regard to it has been made at the station. The results obtained, however, are not applicable, of course, to all waters, for undoubtedly the coloring matter in some waters would be of a more stable nature and hence more difficult to remove than that in the water experimented with. It seems very probable, however, that the highly colored surface waters drawn from some of the ponds and reservoirs in the State and used for public supplies may resemble more nearly in the composition of their coloring material the water used in these special experiments than the Merrimack River water. If this is so, a larger percentage of their color can be removed by sand filtration than is the case with the river water, as our experiments have shown.

During 1899 one of our large cypress tanks, 6 feet in depth and 17 feet 4 inches in diameter, having a capacity of about 9,000 gallons, began to be used as a reservoir for the growth of organisms (see page 465). During 1900 this reservoir was also used as a source for colored water applied to various experimental filters, this

water being given a comparatively high color by various means, such as the addition to it at different times of grass, hay, decayed wood and peat, or infusions of these various substances. As the capacity of the reservoir was comparatively small for the volume of water used, the daily change of color of the water drawn from it varied considerably at times, owing to the necessity of constantly adding colored water or material to produce color.

The coloring matter in water is largely of a vegetable origin, and a highly colored water for this reason shows a large amount of oxygen consumed from permanganate, owing to the carbonaceous matter present. It has been noted, however, by several observers that considerable of the coloring matter in some surface waters even is due to iron; that is to say, in ponds where the vegetable matter is decaying, considerable iron from this matter goes into solution in the water, to be partially or entirely precipitated when oxygen has access to this water. Samples of water drawn from the bottom of a pond, having but little color when first collected, often become reddish, owing to the oxidation of the iron primarily in solution in them. If the water contains but little organic matter, this iron will generally precipitate rapidly, but if considerable organic matter is present, its precipitation may be delayed very considerably.

As an illustration of the source of iron in water and of the delay in decolorization of the water when iron is present, even when exposed to sunlight, the following experiments are given: upon October 4 three one-half gallon bottles were filled with water having a color of 0.31; 50 grams of peat were added to the water in the first bottle, 12.5 grams of grass to the water in the second bottle, and 25 grams of decayed wood to the water in the third bottle. The peat contained .23 per cent. of iron, the grass .13 per cent., and the wood .19 per cent. The color of these three infusions at the end of twenty-four hours and the color and iron at the end of two weeks were as follows: —

Number.	Color after Twenty-four Hours.	Color after Two Weeks.	Iron after Two Weeks.
1,	1.46	1.54	.0480
2,	2.75	5.80	.0800
3,	1.90	5.50	.0600

Upon October 31 the three infusions were filtered through paper, placed in stoppered bottles and allowed to stand in the laboratory exposed to the sunlight, the color of the three on this date being as follows: —

Number.	Color.	Number.	Color.
1,	1.55	3,	6.00
2,	6.20		

Keeping the water in the sunlight for two months, however, did not diminish its color; in fact, at the end of the year that of No. 3 was practically the same as at the start, while the colors of Nos. 1 and 2 had become somewhat greater. Experiments in which the water that was used contained considerably more iron but little organic matter became practically colorless in a few days, owing to the precipitation of iron; while in other experiments, in which the water was quite highly colored but contained no iron, the water became bleached when exposed to the sunlight for about two months.

On account of the easy oxidation of the fermenting organic matter in the colored water in the supply tank, there were periods in the summer when the dissolved oxygen disappeared from the water and it was almost impossible to introduce enough by aeration to last while the water was passing through the filters and the organic matter contained in it undergoing bacterial oxidation, although various devices for aerating the water as it passed to the filters were used.

Filters Nos. 144, 144 A, 147 and 148, receiving Colored Water.

These four filters were constructed of sand, the chemical analysis of which is given on the following table: —

Chemical Analyses of Average Samples of Sand from Filters Nos. 144, 144 A, 147 and 148.

	Sand 144.			Sand 144 A.			Sand 147-148.		
	I.	II.	Av.	I.	II.	Av.	I.	II.	Av.
Per cent. of silica and insoluble matter,	95.48	95.63	95.56	96.14	96.38	96.26	95.76	95.72	95.74
Per cent. of iron and aluminum oxides,	2.55	2.55	2.55	2.32	2.19	2.26	2.45	2.47	2.46
Per cent. of calcium carbonate,	0.44	0.47	0.46	0.39	0.39	0.39	0.45	0.43	0.44
Per cent of magnesium carbonate, sodium and potassium oxides.*	1.53	1.35	1.43	1.15	1.04	1.11	1.34	1.38	1.36
Total,	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* By difference.

Removal of Color by Filter No. 144.

This filter was $\frac{1}{10000}$ of an acre in area and contained $3\frac{1}{2}$ feet in depth of sand of an effective size of 0.24 millimeter. It was put into operation June 13, receiving the water from Supply Tank No. 7, and was operated continuously at first at the rate of 1,000,000 gallons per acre daily. The average rate of operation is shown upon the table on page 464, and varied from an average of 935,000 gallons per acre daily in July to 2,057,000 gallons per acre daily in August; the intended rate being 1,000,000 gallons per acre daily in June, July and August, and 2,000,000 gallons per acre daily during the remainder of the year. Although started as a continuous filter, it was changed to an intermittent filter on July 6, and was so continued throughout the remainder of the year, its surface being uncovered a minimum of two hours daily.

Owing to the character of the water applied to the filter, however, further aeration was necessary at times beyond that given by surface exposure and partial draining of the filter. Daily readings of the color of the applied water and effluent of Filter No. 144 were made from the time of starting the filter until the end of the year, the average result of these readings being as follows: —

Color Removal by Filter No. 144.

	Rate, 1,000,000 Gallons per Acre Daily.			Rate, 2,000,000 Gallons per Acre Daily.			
	June.	July.	August.	September.	October.	November.	December.
Average color of applied water,	.67	.69	.48	.64	.56	.57	.55
Average color of effluent,	.17	.18	.10	.22	.20	.30	.42
Per cent. of color removed,	74.60	73.90	79.20	65.60	64.30	47.40	23.60

Filter No. 144 A.

This filter was put into operation upon July 6 and contained 30 inches in depth of sand of an effective size of 0.24 millimeter. It was first operated continuously at a rate of 2,500,000 gallons per acre daily, the water applied to it having first passed through a tank containing strips of iron, similar to that described as successful in

treating Provincetown water (see page 548, report of 1899) to see if enough iron would be taken into solution by the dissolved gases of the water to subsequently coagulate and precipitate as hydrate, carrying the coloring matter with it. The filter was operated in this manner until September 12, but was less successful in removing the coloring matter of the water, as will be seen by the table below, than Filter No. 144, to which the water went without any preliminary treatment. This result was undoubtedly due to the additional iron that was taken into solution becoming partially oxidized, but at times prevented from precipitating because of insufficient aeration and the organic matter present.

Upon September 12 sulphate of alumina in the proportion of 2.0 grains per gallon began to be applied to this water. Upon October 11 the amount was reduced to 1.0 grain per gallon, but upon November 2 it was again placed at 2.0 grains per gallon, and so continued throughout the remainder of the year, as it was found that this amount was generally necessary for successful work. The average rate of operation of this filter is shown by the table on page 465, and varied from 1,113,000 gallons per acre daily in September to 2,596,000 gallons per acre daily in December. The following table shows the color of the applied water and effluent and the percentage removal: —

Color Removal by Filter No. 144 A.

	July.	August.	September.	October.	November.	December.
Average color of applied water, ...	1.01	.54	.51	.53	.55	.74
Average color of effluent, ...	.35	.21	.03	.21	.09	.06
Per cent. of color removed, ...	65.30	61.10	94.10	60.40	83.60	91.90

The average color of the effluent of this filter was .03 in September, when 2.0 grains per gallon of sulphate of alumina were being added, as shown by the table. Upon the reduction of this in October to 1.0 grain per gallon, the color removal was much less, the average for the remainder of the month and the first two or three days in November being .30; but upon again increasing the amount of sulphate of alumina to 2.0 grains, the low color previously given with this amount of chemical was generally obtained. In operating this

filter the sulphate of alumina was applied in different ways, allowing different periods of time to elapse after its mingling with the water before this water reached the surface sand of the filter, and it was found that better results were obtained if this period was about one hour than when it was less, but that a greater period was little if any better in causing more perfect coagulation. Starting with 30 inches in depth of sand, this was gradually reduced to 2½ inches, before new sand was added, without affecting the color results obtained.

Alkalinity and Limit of Amount of Sulphate of Alumina.

The alkalinity of water is due to carbonates and bicarbonates of lime and magnesia, and the power of the water to decompose sulphate of alumina depends directly upon its degree of alkalinity. The alkalinity of our colored water supply averaged 1.9 parts per 100,000 parts during the year, varying from 1.0 to 2.5 parts for monthly averages. As about 0.6 of a part of alkalinity is required to decompose 1.0 grain per gallon of sulphate of alumina, it was at times impossible, unless the alkalinity of the water was increased artificially, to use the 2.0 grains per gallon without causing the effluent of this filter to give an acid reaction, caused by the presence of undecomposed sulphate of alumina. This occurred on several occasions.

Filter No. 147.

This filter was $\frac{1}{20000}$ of an acre in area and contained 27 inches in depth of sand of an effective size of 0.24 millimeter. It was put into operation upon July 27 as a continuous filter, at the rate of 3,000,000 gallons per acre daily, and the rate of operation during the last five months of the year varied from 1,736,000 gallons per acre daily in November to 2,650,000 gallons per acre daily in December. Although started as a continuous filter, it soon had to be operated in the intermittent manner, owing to the character of the water applied to it during the summer months; and, as stated when describing Filter No. 144, the water had to be aerated to introduce sufficient air to last while passing through the filter, besides that introduced by the intermittent method of operation.

Beginning October 12 ferric chloride was applied to the water in the proportion of .15 of a grain per gallon, a period of about forty minutes elapsing after the addition of the chemical before the water passed to the filter. Upon November 8 the amount added was in-

creased to .75 of a grain per gallon, upon November 13 to 1.5 grains per gallon, and upon November 14 it was reduced to .75 of a grain per gallon, this amount being sufficient to cause the coagulation of a considerable percentage of the coloring matter of the water when the ferric chloride was changed to sesquioxide of iron. The small amount first added caused but a slight reduction of the coloring matter of the water beyond that which had been previously removed by the filter by simple sand filtration without the addition of the chemical, and a greater amount than .75 of a grain per gallon caused iron to appear at times in the effluent. The following table shows the per cent. of color removed: —

Color Removal by Filter No. 147.

	July.	August.	September.	October.	November.	December.
Average color of applied water,	.60	.48	.68	.56	.57	.55
Average color of effluent,	.29	.17	.37	.26	.16	.08
Per cent. of color removed,	51.70	64.60	45.60	53.60	71.90	86.40

The average color of the effluent from November 14 to the end of the month, when the amount of ferric chloride was increased to .75 of a grain per gallon, was .04, and the average color of the applied water during this period was .58, showing a removal of 93 per cent.

Filter No. 148.

This filter was 20 inches in diameter and contained 27 inches in depth of sand of an effective size of 0.24 millimeter. It received water of the same character as that applied to the three filters just described; but before reaching the filter the water passed, from the date it was first put into operation until October 11, through a small tower of broken brick 2 feet in depth, and from October 11 to the end of the year through a tower of fine broken stone, the object being partly to aerate the water thoroughly before passing to the filter, to see if more color could be removed by this means, and partly for a study upon the removal of odor. The following table shows the percentage removal of color by this filter, and a comparison can be made of the results obtained by intermittent filtration through this shallow filter, and the results obtained by intermittent filtration, during the

last four months of the year when the rates were similar, through the somewhat deeper Filter No. 144 (see page 464). These results would seem to indicate, contrary to the results spoken of in discussing Filters Nos. 3 B and 8 A, on page 453, that the deeper the sand the greater the removal of color. This was a new filter, however, containing clean sand without the coating of organic matter and bacteria on the sand grains that obtained in Filters Nos. 3 B and 8 A.

	July.	August.	September.	October.	November.	December.
Average color of applied water,	.60	.47	.74	.55	.57	.55
Average color of effluent,	.28	.21	.40	.33	.41	.42
Per cent. of color removed,	53.30	55.30	45.90	40.00	28.10	23.60

Treatment with Potassium Permanganate.

Upon December 1 we began to treat the water with potassium permanganate before it passed to Filter No. 148, and, while we have had considerable success in removing color and iron by means of this chemical when treating a water containing considerable iron, it was not successful in removing color from this water with the period of storage allowed after its addition before filtration. Further experiments are now being made.

The Relation of Percentage of Dissolved Oxygen present in a Water to the Results obtained upon the Removal of Color by Filtration.

It is well known that the purification of a water supply by sand filtration is unsuccessful, from a bacterial point of view, without a sufficient supply of dissolved oxygen in the water. Poor chemical results are, of course, also obtained when oxygen is lacking; but the need of oxygen in the removal of color from water is perhaps more plainly shown than in any other class of filtration. Through the months of August, September and October, when the water in the colored water supply tank was rich in easily oxidized organic matter taken from the hay, peat, etc., the amount of air necessary for successful filtration was with difficulty introduced into the water. There was a period from the last of August until September 12 and also a number of days during October when oxygen was entirely absent from the water in the supply tank, and any method of aeration

before passing the water to the filters which we were at first able to devise would not introduce more air into this water than would be almost immediately used. Later, aerators were placed above the tanks, which seemed to answer the purpose, but from time to time these failed to introduce the requisite amount, and this was quickly shown not only by the lack of oxygen in the effluent of these filters, but also by their high color, due, owing to the absence of oxygen from the water, to iron taken into solution from the sand in the filters and the subsequent oxidation of this iron. On a number of days in the months mentioned the color of the effluents was greater than that of the water applied, this occurring both with the intermittent sand filters as well as with Filters Nos. 144 A and 147, before passing to which the water was treated with sulphate of alumina and ferric chloride respectively. The results obtained upon these days are omitted from the tables showing the percentage of color removed by the filters.

The character of the water in the supply tank during these months is shown by the table on page 464, and it will be noticed that the average analysis of September showed only .0553 parts per 100,000 of albuminoid ammonia and .58 parts of oxygen consumed; yet this matter was in such an unstable condition that the oxygen introduced by the aerators was almost immediately exhausted. For instance, the following figures, showing the percentage of saturation of oxygen in the water applied to the aerator of Filter No. 148, the water from the aerator of Filter No. 148 collected from the surface of the filter, and in the effluent of the filter, will illustrate the difficulty encountered: —

October.	Percentage of Oxygen in Applied Water.	Percentage of Oxygen after Aeration.	Percentage of Oxygen in Effluent.
1,	0.0	14.8	0.0
3,	0.0	34.0	0.0
4,	0.0	21.5	0.0
6,	17.7	40.4	0.0
8,	0.0	29.9	0.0
10,	0.0	29.7	0.0
11,	0.0	27.9	0.0
15,	0.5	50.9	10.4
17,	11.8	50.7	3.6
19,	24.7	58.7	27.4

Average Chemical Analyses of Water applied to and Effluents from Filters Nos. 144 to 148 inclusive.

The following tables present the average analyses of the colored water applied to and the effluents of these filters. In the case of Filters Nos. 144, 144 A and 147, two averages are given: those for Filter No. 144 showing the average result when filtering at the different rates noted on the table; those for Filter No. 144 A presenting (1) the average of the period when the applied water passed through an iron contact filter before going upon Filter No. 144 A, and (2) the average effluent when sulphate of alumina was used; and those for Filter No. 147 showing the periods before and after using ferric chloride. It will be noticed that the effluent of Filter No. 144 was of a considerably better quality during the second period, when the rate was greater, but this was due to the different character of the applied water during the two periods and the difficulty at times in introducing sufficient oxygen during the first period, covering June, July, August and a portion of September.

Average Analysis of Colored Water.

[Parts per 100,000.]

1900.	Temperature. — Deg. F.	Color.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.
			Free.	Albuminoid.			Nitrates.	Nitrites.	
				Total.	Soluble.				
July,	79	69	.0123	.0448	.0334	.20	.0060	.0003	.59
August,	74	48	.0113	.0754	.0447	.29	.0050	.0001	.77
September,	67	64	.0967	.0553	.0519	.30	.0056	.0003	.58
October,	60	56	.0391	.0706	.0611	.26	.0068	.0001	.80
November,	48	57	.0191	.0282	.0229	.26	.0108	.0003	.64
December,	38	55	.0091	.0221	.0201	.25	.0170	.0003	.64
Average,	61	58	.0313	.0494	.0390	.26	.0085	.0002	.67

Average Analyses of Effluent of Filter No. 144.

Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.
	Applied Water.	Effluent.	Free.	Albuminoid.		Nitrates.	Nitrites.		
1,064,000	73	72	.0089	.0209	.24	.0119	.0011	.30	20.4
2,002,000	49	49	.0014	.0140	.26	.0274	.0000	.37	52.3

Average Analyses of Effluent of Filter No. 144 A.

Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.
	Applied Water.	Effluent.	Free.	Albuminoid.		Nitrates.	Nitrites.		
1,550,000	73	72	.0359	.0302	.27	.0247	.0005	.38	33.5
1,866,000	49	49	.0080	.0098	.26	.0219	.0002	.16	51.4

Average Analyses of Effluent of Filter No. 147.

2,299,000	71	71	.0472	.0343	.35	.0038	.0002	.43	34.5
2,075,000	49	48	.0077	.0123	.73	.0199	.0002	.22	52.8

Average Analysis of Effluent of Filter No. 148.

2,610,000	57	58	.0199	.0325	.29	.0181	.0013	.53	30.5

Experiments upon the Removal of Organisms and Odors from Water.

Removal of Organisms.

As before stated, we began to use Tank 7 during 1899 as a reservoir of water for the growth of organisms, being first filled with canal water, and a certain volume of well-purified sewage effluent being added to it daily, this effluent, of course, containing a large amount of nitrates. Upon May 25 of that year there were added to the water in the tank about 1,000 gallons of water from a pond in the neighborhood, which was found to contain *Uroglena* and many other organisms. Microscopical examinations of the water in the supply tank were made from time to time during this year and but few were found. When in 1900 we began the experiments upon the removal of color from water, an attempt was again made to grow organisms in the supply tank, and many microscopical examinations of this water were made from the beginning of July until the end of the year. At first, samples were taken from the first foot in depth of the water in the tank, and this method of collection was followed during July, August and part of September. As the water seemed to have odors not accounted for by the small number of organisms found in these surface samples, however, we began during the last part of September to collect samples from the surface, mid-depth and bottom of the tank, although the total depth of water was not over 5 feet.

The following tables show the variety of organisms found during the period of investigation from July 1 until the end of the year, the first table giving the organisms found in the surface water from July 1 until the last part of September, and the following table giving the organisms found in the samples taken from different depths on different days between September 25 and December 31. It will be noticed that the organisms found during the first period were comparatively few in number, but several were present which are known to cause odor in waters, such as *Asterionella*, *Diatoma*, *Meridion*, *Tabellaria*, *Eudorina*, *Pandorina*, *Dinobryon*, etc. The samples during the second period, from the end of September until the end of the year, showed many other organisms present which are either known or supposed to produce odors. The table shows that a very large number of organisms was found in the bottom of the tank, compared with the number found at the surface or mid-depth. Upon the tables a statement is given of the number of samples examined.

Organisms per Cubic Centimeter in Supply Tank (First Period).

[Fifteen Samples examined upon Different Dates.]

	Number of Times found.	Average Number found.	Maximum Number found.		Number of Times found.	Average Number found.	Maximum Number found.
Asterionella, .	5	13	29	Scenedesmus, .	8	15	32
Cyclotella, . .	2	2	2	Spirogyra, . .	4	8	24
Diatoma, . .	1	2	2	Staurastrum, .	5	3	8
Epithemia, . .	6	3	8	Staurogenia, . .	1	1	1
Melosira, . .	3	59	160	Xanthidium, . .	2	6	8
Meridion, . .	1	1	1	Leptothrix, . .	1	96	96
Navicula, . .	10	6	21	Zoöglœa, . .	15	26	240
Pinnularia, . .	1	1	1	Chlamydomonas, .	1	30	30
Stephanodiscus, .	1	2	2	Cryptomonas, .	2	6	8
Synedra, . .	12	142	1,360	Dinobryon, . .	1	14	14
Tabellaria, . .	9	4	12	Euglena, . .	7	5	16
Aphanocapsa, .	2	2	2	Euglena acus, .	1	144	144
Chroöcoccus, .	1	10	10	Halteria, . .	2	1	1
Oscillaria, . .	3	4	8	Monas, . . .	3	1	1
Arthrodesmus, .	3	4	8	Peridinium, . .	4	7	14
Cladophora, . .	1	8	8	Phacus, . . .	1	16	16
Closterium, . .	8	4	22	Trachelomonas, .	7	104	638
Cœlastrum, . .	1	2	2	Vorticella, . .	1	4	4
Conferva, . .	1	1	1	Anguillula, . .	1	1	1
Cosmarium, . .	2	5	8	Anuræa, . .	3	6	7
Desmidium, . .	2	17	32	Asplanchna, . .	1	2	2
Eudorina, . .	1	1	1	Brachionus, . .	1	12	12
Pandorina, . .	3	12	32	Triarthra, . .	1	1	1
Pediastrum, . .	1	1	1	Cyclops, . .	3	-	-
Protococcus, . .	6	86	246	Daphnia, . .	1	-	-
Raphidium, . .	1	80	80				

Organisms per Cubic Centimeter in Supply Tank (Second Period).

[Eighteen Samples examined.]

	Surface.			Mid-depth.			Bottom.		
	Number of Times found.	Average Number found.	Maximum Number found.	Number of Times found.	Average Number found.	Maximum Number found.	Number of Times found.	Average Number found.	Maximum Number found.
Asterionella, . .	5	2	4	5	3	5	17	732	2,900
Cyclotella, . .	-	-	-	-	-	-	3	267	300
Cymbella, . .	-	-	-	-	-	-	2	50	50
Diatoma, . .	-	-	-	-	-	-	9	372	800
Epithemia, . .	7	1	3	4	2	3	18	872	2,800
Eunotia,. . .	-	-	-	-	-	-	1	100	100
Fragilaria, . .	-	-	-	-	-	-	2	2,400	4,000
Melosira, . .	1	3	3	3	6	8	12	704	1,850
Meridion, . .	-	-	-	-	-	-	5	290	600
Navicula, . .	7	2	8	2	3	4	18	2,736	15,600
Pleurosigma, . .	-	-	-	-	-	-	1	50	50
Stauroneis, . .	-	-	-	-	-	-	15	150	600
Synedra, . .	9	2	7	12	2	3	18	9,739	46,000
Tabellaria, . .	3	1	1	6	4	12	17	553	1,500
Aphanocapsa, .	1	1	1	-	-	-	-	-	-
Oscillaria, . .	-	-	-	1	1	1	16	138	300
Arthrodesmus, .	-	-	-	-	-	-	1	50	50
Closterium, . .	2	1	1	1	1	1	13	181	600
Cœlastrum, . .	-	-	-	-	-	-	3	67	100
Conferva, . .	-	-	-	-	-	-	1	200	200
Cosmarium, . .	-	-	-	-	-	-	2	50	50
Desmidium, . .	-	-	-	-	-	-	1	50	50
Draparnaldia, .	-	-	-	-	-	-	1	100	100
Euastrum, . .	-	-	-	-	-	-	1	50	50
Pediastrum, . .	1	1	1	-	-	-	15	127	400
Protococcus, . .	1	8	8	-	-	-	8	713	2,000
Raphidium, . .	-	-	-	-	-	-	1	50	50
Scenedesmus, .	3	1	1	1	1	1	18	422	1,700
Staurastrum, . .	-	-	-	-	-	-	4	63	100
Staurogenia, . .	-	-	-	-	-	-	1	200	200
Ulothrix, . .	-	-	-	-	-	-	2	125	200
Crenothrix, . .	-	-	-	1	11	11	1	100	100
Leptothrix, . .	1	2	2	-	-	-	-	-	-
Zoöglœa, . .	18	5	10	18	5	10	-	-	-
Actinophrys, . .	1	1	1	-	-	-	2	50	50

Organisms per Cubic Centimeter in Supply Tank (Second Period) — Concluded.

[Eighteen Samples examined.]

	SURFACE.			MID-DEPTH.			BOTTOM.		
	Number of Times found.	Average Number found.	Maximum Number found.	Number of Times found.	Average Number found.	Maximum Number found.	Number of Times found.	Average Number found.	Maximum Number found.
Arcella,	1	2	2	-	-	-	2	50	50
Acineta,	-	-	-	-	-	-	1	50	50
Anthophysa,	1	1	1	-	-	-	-	-	-
Ciliated infusorian,	6	1	3	1	1	1	17	106	200
Cryptomonas,	3	1	2	1	2	2	8	213	300
Dinobryon,	4	14	31	-	-	-	-	-	-
Euglena,	2	1	1	1	1	1	1	100	100
Euplotes,	1	1	1	-	-	-	-	-	-
Halteria,	4	2	4	2	2	3	5	190	450
Mallomonas,	1	1	1	-	-	-	-	-	-
Monas,	4	3	4	2	4	4	14	168	500
Paramœcium,	7	2	7	3	1	1	12	92	200
Peridinium,	7	1	2	2	2	2	10	180	800
Phacus,	-	-	-	1	1	1	4	63	100
Stentor,	-	-	-	-	-	-	2	75	100
Synura,	1	1	1	1	1	1	1	150	150
Trachelomonas,	2	1	1	2	1	1	5	70	100
Trinema,	-	-	-	-	-	-	1	50	50
Uroglena,	5	2	5	1	1	1	1	50	50
Vorticella,	4	2	3	-	-	-	9	100	200
Anuræa,	-	-	-	1	1	1	1	100	100
Brachionus,	-	-	-	-	-	-	1	200	200
Diglena,	-	-	-	-	-	-	2	75	100
Mastigocerca,	-	-	-	-	-	-	1	50	50
Notholca,	-	-	-	-	-	-	1	200	200
Polyarthra,	1	1	1	1	1	1	-	-	-
Rotatorian,	1	1	1	-	-	-	14	129	500
Rotatorian ova,	1	1	1	-	-	-	-	-	-
Rotifer,	-	-	-	-	-	-	3	67	100
Synchæta,	-	-	-	-	-	-	1	100	100
Cyclops,	3	-	-	4	-	-	-	-	-
Amorphous matter,	18	-	-	17	-	-	-	-	-
Mites,	1	-	-	-	-	-	-	-	-
Sponge spicules,	-	-	-	-	-	-	14	275	1,400

Removal of Odor.

Asterionella, *Diatoma*, *Synedra* and *Meridion* were present in the water during the entire period of experiment, and other odor-producing organisms, such as *Cyclotella*, *Diatoma*, *Meridion*, *Tabellaria*, *Cryptomonas*, *Volvox*, *Eudorina*, *Pandorina*, *Uroglena*, *Dinobryon* and *Peridinium*, for a considerable portion of the time.

A large percentage of the variety of organisms in the applied water was found in the effluents of all these filters but only occasionally were they present in the effluents and in very small numbers.

The odor of the water and the odor of the effluents of the filters to which this water was applied were noted daily, the odor when both cold and heated to the boiling point being taken. Owing, however, to the manner in which the color was maintained in our supply tank, most of the odors noted at certain periods were undoubtedly due to decaying organic matter rather than to any of the organisms present. But at times odors evidently caused by these organisms were detected, and these odors sometimes remained in the water in the supply tank for many days.

It is of little value to make a statement of the odors of the effluent of more than one of these filters, for the odor of the effluent of each filter was practically the same through the entire period, only minor differences being noted from time to time. Filters Nos. 144 A and 147 were operated with the use of sulphate of alumina and ferric chloride respectively, for the purpose of removing color, but their effluents were not rendered more odorless by the use of these chemicals than the effluent of Filter No. 144, a plain intermittent sand filter.

In a general way it can be said (1) that during a considerable portion of the period of experiment there were odors in the supply water which would be detected by an ordinary user, but not in the effluents; (2) that during a considerable portion of the period of operation the odors found in the applied water were found in the effluents, but to a much less degree whenever an abundance of oxygen was present in the water as it passed through the filter, this being the case during a very large portion of the time; and (3) that the musty and offensive odors due to decaying vegetable matter were more easily removed than the odors presumably due to organisms.

Studying the odor of the water in the supply tank by months, and the odor of the effluent of Filter No. 144 also by months, the following statements can be made: during July the odor of the supply varied from "slightly aromatic" to the odor of decaying organic matter. The odor of the effluent of Filter No. 144 during July was very much less than that of the applied water, only on one or two occasions was a slight odor of decaying organic matter detected, and during a portion of the month the odor was "slightly sweetish and aromatic," upon one date being "slightly geranium," due undoubtedly to the large number of *Asterionella* in the supply tank.

During August the odor of the water in the supply tank was never that of decaying organic matter, but largely "geranium" and "aromatic;" but the odor of the effluent of Filter No. 144 was designated as "offensive" during more than half the month and as "geranium" during a number of days in the month, the offensive odor being due to insufficient oxygen in the applied water, causing an entire absence of oxygen in the effluent during a considerable portion of this month.

During September the odor of the water in the supply tank varied from "moldy" to "decidedly disagreeable." During a considerable portion of this month there was an utter lack of oxygen in this water, owing to the rapid decomposition of the organic matter taken from the hay and grass with which the water was colored. Filter No. 144 was out of operation at least one-half of the month, owing to the difficulty experienced in introducing enough oxygen into the water to last while it was passing through the filter, as before noted, but the odor of the effluent when this was finally accomplished by improved aeration was very much less than that of the applied water, only a very slight odor being detected in this effluent during the last portion of the month.

In October the odor of the water in the supply tank was "offensive" during the first two weeks of the month, but during the last two weeks it varied from "slightly offensive" to "slightly geranium." During this month the odor of the effluent of Filter No. 144 was "slightly geranium" or "slightly grassy" on days when a sufficient amount of oxygen was introduced into the applied water to last while the water was passing through the filter, but "musty" on the days when the amount of oxygen in the effluent was very small or entirely lacking.

During November the water in the supply tank had an odor varying on different days from "decidedly musty" to "very slightly geranium;" the odor of the effluent of Filter No. 144 being "very slightly musty" when cold during the first week of the month, but without odor hot during the entire month, and "none" or "slightly sweetish" when cold during the last three weeks of the month.

During December the odor of the water in the supply tank varied from "musty" to "geranium," while the effluent of Filter No. 144 had practically no odor whatever, either cold or hot.

Description of Operation of Experimental Filters receiving Merrimack River Water and the Lawrence City Filter during 1900, together with Tables of Results.

Filters Nos. 3 B and 8 A.

These two filters are each $\frac{1}{200}$ of an acre in area, and at the beginning of the year Filter No. 3 B contained 27½ inches in depth of sand and Filter No. 8 A 28½ inches, the sand in both filters being of the same character and having an effective size of 0.23 millimeter. These two filters were first put into operation in 1893, and a summary of the results obtained from them up to Jan. 1, 1900, was given in the last report of the Board. The rate of operation of the filters had been 2,500,000 gallons per acre daily during 1899, but it was reduced in each case to 1,500,000 gallons per acre daily upon Jan. 19, 1900, in order to make a study of their *B. coli* efficiency when operated at low rates, as discussed on previous pages. Upon May 9 the roof of planking covered with earth, that had been over Filter No. 3 B since September, 1896, was removed, but that over Filter No. 8 A was allowed to remain. Daily samples of the water applied to and the effluent from these filters were taken for bacterial analysis and frequent samples for chemical analysis. Tables giving the results of these various determinations follow: —

Average Daily Number of Bacteria per Cubic Centimeter in the Canal Water (Merrimack River), 1900.

Day.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	6,200	5,400	2,200	–	1,100	5,300	–	8,200	2,400	900	6,100	3,800
2,	9,000	6,100	7,100	2,600	28,100	1,100	5,300	8,100	–	600	7,800	–
3,	4,700	9,400	5,600	3,500	11,900	–	6,500	4,200	–	6,200	3,800	6,900
4,	9,200	–	–	3,100	1,300	2,600	–	2,300	1,900	9,800	–	2,700
5,	7,600	14,400	2,600	2,800	1,400	4,100	4,200	–	1,300	5,300	1,400	8,500
6,	16,500	9,400	4,100	1,100	–	3,400	4,500	800	1,100	11,400	5,100	7,700
7,	–	3,800	2,700	2,700	900	7,400	5,100	400	2,300	–	3,600	3,200
8,	11,800	11,600	2,100	–	500	6,200	–	1,900	2,300	3,100	3,900	3,300
9,	21,300	3,800	2,800	1,600	1,600	4,100	2,100	900	–	1,100	3,100	–
10,	9,500	11,200	4,300	–	3,100	–	1,500	2,700	800	19,400	24,300	4,300
11,	10,800	–	–	4,000	1,000	2,300	8,100	1,400	1,100	–	–	1,900
12,	6,500	12,000	6,600	1,600	1,400	12,000	6,800	–	2,500	18,700	8,800	3,200
13,	7,800	7,300	3,300	1,700	–	3,200	4,300	1,100	3,700	7,400	6,800	3,800
14,	–	–	3,000	2,400	2,700	2,800	2,300	7,800	1,600	–	3,100	3,400
15,	12,300	–	3,700	–	3,000	1,700	–	1,900	1,900	6,100	2,900	3,900
16,	11,800	–	1,800	900	9,100	3,100	1,100	1,600	–	10,800	6,900	–
17,	12,400	–	7,500	1,600	1,800	–	1,000	–	1,100	6,500	6,900	5,100
18,	16,400	–	–	1,600	900	–	4,500	3,400	1,700	16,000	–	4,500
19,	11,300	–	2,500	–	8,300	2,700	2,300	–	2,100	3,200	8,100	9,300
20,	14,400	4,600	3,100	700	–	3,300	3,900	8,500	19,800	7,700	10,300	6,100
21,	–	3,100	3,300	–	4,800	13,300	1,100	2,400	15,100	–	4,400	7,100
22,	10,700	–	2,800	–	3,700	6,400	–	7,300	3,100	3,800	4,400	5,000
23,	18,500	3,800	2,700	–	1,900	9,700	800	10,300	–	1,100	–	–
24,	14,300	8,300	4,000	–	1,800	–	900	6,700	1,300	4,500	1,600	5,100
25,	11,700	–	–	–	2,500	3,200	2,400	4,400	1,100	3,900	–	–
26,	9,700	8,200	2,700	1,800	800	2,100	3,300	–	8,100	4,600	10,600	3,800
27,	7,300	2,700	1,200	300	–	3,100	3,100	900	12,100	4,600	7,900	4,300
28,	–	2,200	1,200	2,100	11,000	3,900	4,800	2,400	5,400	–	2,400	2,300
29,	15,300	–	2,100	–	1,600	3,900	–	5,400	3,600	2,000	–	1,400
30,	4,300	–	1,000	1,900	–	3,500	800	1,700	–	2,600	3,800	–
31,	16,300	–	2,100	–	1,600	–	500	2,200	–	6,900	–	2,100
Average,	11,400	7,100	3,300	2,000	4,100	4,600	3,200	3,800	4,100	6,500	6,200	4,500

Average Daily Number of Bacteria per Cubic Centimeter in the Effluent of Filter No. 3 B, 1900.

Day.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	62	416	-	-	-	7	-	13	10	5	12	22
2,	120	414	-	14	-	7	10	14	-	15	33	7
3,	132	164	-	20	-	-	40	14	-	10	10	26
4,	104	-	-	24	-	21	-	6	44	18	-	31
5,	143	137	-	13	-	8	27	-	7	23	9	20
6,	340	55	-	19	-	9	15	28	17	11	10	40
7,	-	119	-	14	-	12	11	5	24	-	9	25
8,	86	29	163	-	-	6	-	6	11	17	6	32
9,	102	89	138	28	-	14	13	4	-	8	11	-
10,	121	51	126	20	-	-	10	7	10	4	10	90
11,	126	-	-	12	86	19	6	3	10	4	-	97
12,	110	39	-	13	62	6	14	-	10	4	6	134
13,	45	19	174	12	-	12	19	10	6	13	5	145
14,	-	-	123	23	49	-	43	11	7	-	7	139
15,	107	-	96	-	21	-	-	6	28	13	223	331
16,	47	-	183	27	9	32	7	5	-	14	336	-
17,	54	-	41	11	17	-	6	6	15	6	190	436
18,	31	-	-	16	10	-	5	16	15	10	-	235
19,	165	-	153	-	14	7	5	-	9	5	154	248
20,	43	94	56	17	-	9	41	81	62	8	53	146
21,	-	75	58	-	35	7	27	6	48	-	28	226
22,	84	-	-	-	20	5	-	19	10	7	27	266
23,	73	22	-	-	17	6	22	12	-	5	14	-
24,	40	20	-	-	23	-	20	49	6	4	17	76
25,	53	-	-	-	6	5	54	7	5	16	-	-
26,	45	-	88	-	29	13	9	-	13	7	22	40
27,	41	-	26	31	-	5	10	18	6	8	49	43
28,	-	-	23	-	6	5	5	9	13	-	60	17
29,	33	-	28	-	8	5	-	15	6	9	-	20
30,	13	-	19	-	-	37	12	19	-	80	40	-
31,	416	-	20	-	7	-	6	6	-	35	-	8
Average,	101	116	89	18	25	11	17	15	16	13	54	112
Per cent. removed,	99.11	98.37	97.30	99.10	99.39	99.76	99.47	99.61	99.61	99.80	99.13	97.51

Average Daily Number of Bacteria per Cubic Centimeter in the Effluent of Filter No. 8 A, 1900.

Day.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	68	19	-	-	8	23	-	6	18	5	4	25
2,	92	28	-	16	4	8	19	4	-	4	17	-
3,	98	53	-	86	7	-	11	8	-	-	12	43
4,	85	-	-	48	9	12	-	16	10	14	-	8
5,	37	28	-	15	10	5	13	-	5	14	2	12
6,	106	23	-	42	-	8	13	6	15	10	4	10
7,	-	16	-	22	7	7	18	9	7	-	10	5
8,	96	45	-	-	5	8	-	5	5	10	4	18
9,	54	26	356	15	13	5	5	3	-	6	6	-
10,	23	22	144	29	10	-	3	8	6	7	2	30
11,	15	-	-	28	6	8	4	3	14	5	-	32
12,	34	29	81	20	12	2	10	-	11	5	5	26
13,	12	16	41	19	-	4	11	2	2	4	6	29
14,	-	-	24	11	7	-	3	6	6	-	7	28
15,	89	-	116	-	14	-	-	6	2	4	7	24
16,	-	-	168	18	14	11	10	5	-	21	5	-
17,	-	-	66	18	30	-	8	7	2	7	5	40
18,	81	-	-	9	5	-	52	4	3	4	-	22
19,	129	-	77	-	3	4	17	-	1	8	13	80
20,	91	-	43	18	-	9	9	4	3	4	7	71
21,	-	223	51	-	20	16	7	5	15	-	7	126
22,	74	-	-	-	8	3	-	9	1	4	5	47
23,	26	35	-	-	19	7	10	7	-	4	-	-
24,	33	133	-	-	8	-	9	4	5	9	8	20
25,	22	-	-	-	8	6	7	5	5	13	-	-
26,	30	-	19	-	1	15	9	-	13	6	7	7
27,	25	-	32	13	-	15	7	2	13	5	5	8
28,	-	-	25	17	17	8	12	11	5	-	20	14
29,	17	-	9	-	11	4	-	9	4	5	-	9
30,	20	-	-	8	-	31	8	14	-	7	25	-
31,	29	-	47	-	6	-	11	7	-	3	-	14
Average,	55	50	81	24	10	10	11	6	7	7	7	30
Per cent. removed,	99.52	99.30	97.55	98.80	99.76	99.78	99.66	99.84	99.83	99.89	99.89	99.33

Monthly Averages of Analyses of Canal Water (Merrimack River).

[Parts per 100,000.]

1900.	Temperature. — Deg. F.	Color.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
			Free.	Albuminoid.			Nitrates.	Nitrites.			
				Total.	Soluble.						
January,	33	.39	.0129	.0232	.0210	.27	.022	.0003	.31	81.6	11,400
February,	34	.39	.0078	.0177	.0164	.23	.016	.0002	.36	87.8	7,100
March,	35	.38	.0026	.0122	.0118	.19	.010	.0000	.41	–	3,300
April,	41	.40	.0016	.0154	.0118	.14	.007	.0002	.34	99.1	2,000
May,	54	.50	.0034	.0164	.0156	.10	.017	.0000	.53	–	4,100
June,	73	.42	.0074	.0187	.0164	.10	.013	.0002	.39	62.1	4,600
July,	77	.34	.0108	.0176	.0139	.21	.010	.0004	.30	59.4	3,200
August,	75	.22	.0135	.0190	.0151	.19	.013	.0004	.26	43.6	3,800
September,	71	.34	.0187	.0193	.0156	.26	.018	.0007	.23	32.5	4,100
October,	62	.32	.0143	.0158	.0144	.26	.016	.0006	.32	47.6	6,500
November,	46	.75	.0046	.0228	.0226	.25	.011	.0000	.80	91.2	6,200
December,	38	.59	.0062	.0222	.0196	.25	.020	.0001	.57	98.0	4,500
Average,	53	.42	.0087	.0184	.0162	.20	.014	.0003	.40	70.3	5,100

Effluent of Filter No. 3 B.

[Parts per 100,000.]

1900.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.			
January,	1,302,600	33	34	.21	.0154	.0102	.35	.038	.0000	.28	75.5	101
February,	1,370,500	34	35	.35	.0012	.0114	.18	.045	.0000	.43	86.3	116
March,	1,451,200	35	36	.28	.0008	.0068	.19	.023	.0000	.35	–	89
April,	1,713,900	41	41	.24	.0008	.0066	.14	.024	.0000	.24	–	18
May,	1,756,400	54	56	.37	.0014	.0094	.09	.023	.0000	.46	38.3	25
June,	1,472,700	73	74	.20	.0011	.0069	.09	.049	.0000	.24	42.7	11
July,	1,512,800	77	78	.12	.0002	.0040	.15	.031	.0000	.34	44.7	17
August,	1,571,500	75	75	.07	.0005	.0055	.19	.017	.0000	.13	42.1	15
September,	1,518,600	71	71	.10	.0002	.0046	.26	.051	.0000	.13	48.1	16
October,	1,693,300	62	58	.23	.0010	.0066	.25	.035	.0000	.28	52.1	13
November,	1,659,300	46	41	.55	.0014	.0176	.25	.024	.0000	.64	87.9	54
December,	1,556,000	38	38	.37	.0014	.0108	.26	.031	.0000	.42	99.2	112
Average,	1,548,200	53	53	.26	.0021	.0084	.20	.033	.0000	.33	61.7	49

Effluent of Filter No. 8 A.

[Parts per 100,000.]

1900.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.			
January,	2,199,000	33	33	.28	.0039	.0096	.27	.047	.0000	.36	56.1	55
February,	1,638,800	.34	34	.27	.0021	.0077	.23	.046	.0000	.34	58.7	50
March,	682,100	35	35	.26	.0002	.0058	.18	.045	.0000	.32	-	81
April,	1,837,300	41	40	.28	.0006	.0082	.14	.017	.0000	.26	78.5	24
May,	1,802,600	54	53	.37	.0008	.0097	.10	.020	.0000	.39	27.3	10
June,	2,024,300	73	73	.23	.0064	.0073	.12	.022	.0007	.27	1.6	10
July,	1,567,500	77	78	.13	.0008	.0062	.14	.017	.0004	.18	29.5	11
August,	1,953,100	75	76	.08	.0041	.0077	.20	.015	.0001	.17	25.6	6
September,	1,772,000	71	71	.10	.0002	.0057	.26	.031	.0002	.14	12.1	7
October,	1,934,000	62	56	.23	.0004	.0076	.25	.034	.0000	.29	29.9	7
November,	1,766,000	46	46	.62	.0008	.0124	.25	.026	.0000	.61	67.9	7
December,	1,895,500	38	38	.37	.0016	·0114	.26	.030	.0000	.43	85.7	30
Average,	1,756,800	53	53	.27	.0018	.0083	.20	.029	.0001	.31	43.0	25

Filters Nos. 142 and 143.

These two filters are $\frac{1}{10000}$ of an acre in area and were put into operation June 12, 1900. Each contains sand of an effective size of 0.20 millimeter, but the depth of sand varies, there being 2 feet in depth in Filter No. 142 and 5 feet in depth in Filter No. 143. The object of operating these two filters was for the purpose of making a comparative study of the removal of *B. coli* by sand filters of different depths, and to each of them canal water (Merrimack River) has been applied during the year at a rate of 1,000,000 gallons per acre daily from June 12 to September 19, and 2,500,000 gallons per acre daily from the latter date until the end of the year. These filters are constructed of wooden tanks which have circular grooves ½ inch in depth cut into the sides, 6 inches apart, throughout the depth of the filter. The following tables give the results of the chemical and bacterial analyses of the effluent of each, and these results are discussed upon previous pages : —

Average Daily Number of Bacteria per Cubic Centimeter in the Effluent of Filter No. 142, 1900.

Day.	June.	July.	August.	September.	October.	November.	December.
1,	-	-	672	174	28	73	37
2,	-	417	283	-	23	35	-
3,	-	830	248	-	37	18	71
4,	-	-	-	88	53	-	31
5,	-	1,073	-	143	35	26	57
6,	-	382	116	202	56	53	51
7,	-	370	174	174	-	43	41
8,	-	-	178	92	13	33	18
9,	-	1,321	440	-	8	35	-
10,	-	2,690	252	116	5	14	27
11,	-	788	119	36	-	-	74
12,	-	952	-	40	13	19	22
13,	-	506	109	42	108	39	37
14,	-	994	45	23	-	14	31
15,	-	-	65	25	25	16	108
16,	-	496	31	-	115	21	-
17,	-	463	39	31	185	25	23
18,	-	183	44	31	67	-	-
19,	1,619	767	-	31	29	29	95
20,	6,200	785	512	52	9	24	162
21,	1,800	492	1,095	37	-	3	173
22,	1,500	-	886	9	77	14	106
23,	1,300	378	253	-	14	-	-
24,	-	209	35	24	20	14	84
25,	3,183	141	342	9	47	-	-
26,	684	126	-	26	8	103	30
27,	642	-	53	29	7	107	17
28,	1,006	-	183	15	-	112	26
29,	958	-	150	8	38	-	42
30,	414	632	70	-	178	54	-
31,	-	1,008	83	-	25	-	12
Average,	1,755	696	249	61	47	39	57
Per cent. removed,	64.90	78.25	93.45	98.51	99.28	99.37	98.73

Average Daily Number of Bacteria per Cubic Centimeter in the Effluent of Filter No. 143, 1900.

Day.	June.	July.	August.	September.	October.	November.	December.
1,	-	-	98	1,194	15	115	43
2,	-	410	66	-	16	27	-
3,	-	286	1,008	-	8	30	173
4,	-	-	1,058	220	33	-	34
5,	-	420	-	104	76	18	35
6,	-	103	278	72	7	10	35
7,	-	33	616	100	-	5	40
8,	-	-	134	153	18	11	15
9,	-	94	143	-	10	6	-
10,	-	328	81	118	19	16	34
11,	-	158	61	208	31	-	116
12,	-	216	-	24	10	14	81
13,	-	156	45	85	3	18	106
14,	-	346	13	56	-	18	40
15,	-	-	33	30	27	21	48
16,	-	146	24	-	37	11	-
17,	-	344	32	19	21	81	189
18,	-	418	4	391	12	-	25
19,	3,470	478	-	618	25	71	84
20,	500	186	286	504	51	104	171
21,	2,100	69	1,196	52	-	28	183
22,	1,800	-	778	8	32	19	153
23,	2,000	107	1,093	-	20	-	-
24,	-	75	1,879	71	11	5	64
25,	1,253	138	2,247	44	286	-	-
26,	850	18	-	96	163	58	55
27,	497	-	288	31	-	188	34
28,	378	-	726	13	-	146	41
29,	428	-	387	17	208	-	21
30,	366	2,080	37	-	307	43	-
31,	-	2,204	440	-	130	-	25
Average,	1,240	383	483	176	61	44	74
Per cent. removed,	75.20	88.03	87.29	95.71	99.06	99.29	98.36

Effluent of Filter No. 142.

[Parts per 100,000.]

1900.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F. Applied Water.	Temperature. Deg. F. Effluent.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
June,	881,000	73	70	.12	.0032	.0096	.11	.016	.0004	.18	44.7	1,755
July,	1,038,000	77	75	.29	.0015	.0064	.17	.013	.0009	.24	4.8	696
August,	1,050,000	75	72	.12	.0068	.0104	.21	.027	.0022	.20	13.5	249
September,	1,474,000	71	63	.17	.0004	.0078	.27	.047	.0007	.13	29.1	61
October,	2,265,000	62	57	.25	.0014	.0102	.25	.029	.0000	.34	33.4	47
November,	2,185,000	46	48	.60	.0008	.0148	.25	.019	.0000	.65	73.6	39
December,	2,399,000	38	39	.52	.0058	.0125	.26	.024	.0000	.45	85.8	57
Average,	1,613,000	63	61	.30	.0028	.0102	.22	.025	.0006	.31	40.7	415

Effluent of Filter No. 143.

[Parts per 100,000.]

1900.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F. Applied Water.	Temperature. Deg. F. Effluent.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Per Cent. of Dissolved Oxygen	Bacteria per Cubic, Centimeter.
June,	960,000	73	70	.08	.0020	.0076	.11	.018	.0000	.14	49.2	1,240
July,	1,083,000	77	75	.31	.0009	.0074	.22	.019	.0005	.16	23.2	383
August,	1,045,000	75	72	.17	.0046	.0092	.21	.017	.0012	.20	24.8	483
September,	1,497,000	71	64	.14	.0002	.0066	.27	.046	.0002	.13	5.3	176
October,	2,387,000	62	57	.24	.0010	.0096	.26	.027	.0000	.31	33.2	61
November,	2,220,000	46	47	.60	.0008	.0128	.25	.019	.0000	.61	66.0	44
December,	2,478,000	38	39	.45	.0028	.0128	.26	.025	.0000	.45	87.2	74
Average,	1,667,000	63	61	.28	.0018	.0094	.23	.024	.0003	.29	41.3	352

Work of the Lawrence City Filter during 1900.

This filter is 2.5 acres in area and is unprotected from the weather by any roof. It was first put into operation in September, 1893, and supplies filtered water to the city of Lawrence. As in previous years we have had numerous samples taken for chemical analysis of the Merrimack River water as it flows upon this filter, of the effluent of the filter collected at the pumping station, and also of the filtered water from three other points upon the distributing system, namely, the outlet of the reservoir, a tap at the Lawrence city hall and a tap at the experiment station. Besides these analyses, moreover, we have during nearly eight months of the year taken samples almost daily for bacterial analysis.

Bacterial Efficiency of Lawrence City Filter.

Averaging the monthly averages of bacteria found in the Merrimack River water applied to and the effluent from the Lawrence city filter, we find that the average number of bacteria in the river water for the year has been 8,970 and the average number of bacteria in the effluent 54, giving a bacterial efficiency for the entire year of 99.40 per cent. The average number of bacteria in the samples collected at the outlet of the reservoir was 49 per cubic centimeter, in the samples collected from a tap at the city hall 49 per cubic centimeter, and in the samples collected from a tap at the experiment station 32 per cubic centimeter. Tables showing the results of the chemical and bacterial analyses of the applied water and filtered water are given beyond, and upon previous pages is given a discussion of the results of the examinations of the filtered water for *B. coli.*

Rate of Operation and Number of Times the Filter was scraped.

With the tables following, giving the average chemical and bacterial analyses, is a table showing the volume of water filtered during the year and also a table showing the number of times each of the beds of the filter was scraped during the year. The table giving the volume of water filtered during the year shows that the average rate of filtration was 1,324,000 gallons per acre daily, and the table of scrapings shows that the entire surface of the filter was scraped about sixteen times during the year.

Volume of Water filtered during 1900.

101.8 million gallons filtered during January.
92.5 million gallons filtered during February.
103.1 million gallons filtered during March.
87.8 million gallons filtered during April.
99.2 million gallons filtered during May.
109.5 million gallons filtered during June.
116.8 million gallons filtered during July.
110.5 million gallons filtered during August.
105.7 million gallons filtered during September.
102.2 million gallons filtered during October.
89.9 million gallons filtered during November.
89.0 million gallons filtered during December.

1,208.0 million gallons filtered during the year.

Table showing Number of Times each Bed was scraped during 1900.

	Number of Bed.																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
January, .	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
February, .	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
March, . .	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
April, . .	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
May, . .	1	1	1	1	1	1	1	1	2	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
June, . .	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1
July, . .	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	2	2	2	1	1	1	1	1
August, .	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	1	2	1	2	2	2	2	2	1	1
September, .	2	2	2	2	2	2	2	2	2	1	2	1	1	2	2	3	2	2	2	2	3	2	1	2	2
October, .	1	1	1	1	2	1½	1½	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
November, .	2	2	2	2	1	1	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	2	2	2
December, .	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total, .	16	16	16	16	16	15½	16½	16	17	16	17	17	16	16	15	15	15	15	16	16	16	16	16	15	15

Average Number of Bacteria per Cubic Centimeter in the Merrimack River Water applied to the Lawrence City Filter and in Samples of the Effluent of the Filter collected at Different Points upon the Distribution System.

Merrimack River Water, at the Intake of the Lawrence City Filter.

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
12,800	12,100	5,000	3,300	3,200	12,500	3,900	7,700	19,200	15,500	6,800	5,600

Effluent of the Lawrence City Filter, taken from a Tap at the Pumping Station.

110	73	36	27	70	68	35	17	18	72	58	64

Effluent at Outlet of the Distributing Reservoir.

106	53	45	23	43	46	24	21	38	33	32	56

Effluent at Tap at Lawrence City Hall.

83	52	50	28	23	43	39	12	27	50	60	48

Effluent at Tap at Experiment Station.

70	45	35	21	17	28	32	27	31	26	25	28

Merrimack River Water as it flows upon the Lawrence City Filter.

[Parts per 100,000.]

1900.	Temperature. Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Soluble.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
January,	33	.33	.0184	.0236	.0207	.34	.018	.0001	.41	1.6
February,	33	.45	.0064	.0240	.0210	.22	.014	.0000	.51	1.2
March,	36	.37	.0021	.0137	.0127	.14	.008	.0000	.36	0.8
April,	45	.35	.0015	.0159	.0123	.17	.008	.0000	.45	0.8
May,	53	.43	.0024	.0160	.0139	.10	.014	.0001	.50	0.7
June,	73	.41	.0083	.0187	.0155	.11	.010	.0001	.40	0.9
July,	75	.37	.0170	.0185	.0136	.17	.006	.0003	.29	1.4
August,	71	.29	.0122	.0187	.0133	.21	.010	.0004	.22	1.5
September,	71	.37	.0238	.0197	.0148	.27	.008	.0005	.31	1.5
October,	61	.40	.0176	.0171	.0150	.26	.012	.0004	.36	1.5
November,	47	.61	.0040	.0228	.0214	.25	.009	.0000	.74	1.3
December,	35	.54	.0059	.0195	.0179	.25	.016	.0002	.56	0.8
Average,	53	.41	.0109	.0190	.0160	.21	.011	.0002	.43	1.2

Effluent of the Lawrence City Filter.

[Parts per 100,000.]

1900.	Temperature. Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Soluble.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
January,	36	.42	.0147	.0098	.0093	.37	.052	.0000	.28	2.4
February,	36	.47	.0078	.0104	.0091	.24	.036	.0000	.35	1.6
March,	37	.37	.0066	.0081	.0068	.14	.026	.0000	.27	1.3
April,	47	.45	.0091	.0063	.0060	.17	.030	.0000	.27	1.6
May,	54	.35	.0087	.0078	.0074	.10	.063	.0000	.29	1.3
June,	70	.35	.0041	.0073	.0063	.11	.035	.0000	.27	1.1
July,	75	.22	.0059	.0051	.0047	.17	.030	.0004	.18	1.6
August,	71	.15	.0050	.0060	.0058	.21	.033	.0001	.14	1.7
September,	79	.33	.0069	.0073	.0065	.25	.036	.0002	.19	1.8
October,	62	.24	.0061	.0074	.0069	.27	.041	.0001	.17	1.8
November,	48	.40	.0080	.0066	.0066	.25	.040	.0000	.21	1.9
December,	38	.39	.0108	.0100	.0093	.25	.028	.0000	.31	1.3
Average,	54	.35	.0078	.0077	.0071	.21	.038	.0001	.24	1.6

Water from the Outlet of the Distributing Reservoir.

[Parts per 100,000.]

1900.	Temperature. Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Soluble.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
January,	36	.33	.0108	.0103	.0101	.35	.050	.0000	.26	2.0
February,	35	.43	.0081	.0100	.0099	.24	.040	.0000	.30	1.6
March,	37	.39	.0047	.0083	.0076	.16	.030	.0000	.25	1.3
April,	46	.30	.0034	.0070	.0063	.19	.031	.0000	.21	1.2
May,	54	.35	.0025	.0099	.0078	.12	.042	.0000	.26	1.2
June,	67	.32	.0011	.0088	.0078	.11	.036	.0000	.24	1.1
July,	70	.19	.0010	.0070	.0065	.17	.031	.0001	.17	1.6
August,	69	.11	.0011	.0076	.0064	.22	.035	.0004	.11	1.7
September,	76	.18	.0008	.0062	.0057	.27	.039	.0003	.17	1.7
October,	65	.14	.0014	.0069	.0053	.26	.044	.0001	.11	1.8
November,	49	.20	.0004	.0078	.0078	.26	.050	.0000	.18	1.8
December,	39	.50	.0047	.0111	.0100	.25	.032	.0000	.33	1.2
Average,	54	.29	.0033	.0084	.0076	.22	.038	.0001	.22	1.5

Water from a Tap at Lawrence City Hall.

[Parts per 100,000.]

1900.	Temperature. Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
January,	39	.33	.0088	.0089	.37	.048	.0000	.25	1.9
February,	43	.41	.0061	.0100	.24	.040	.0000	.30	1.5
March,	41	.39	.0038	.0072	.16	.030	.0000	.24	1.2
April,	49	.32	.0021	.0066	.19	.032	.0000	.23	1.0
May,	57	.40	.0010	.0084	.11	.042	.0000	.26	1.0
June,	66	.29	.0007	.0072	.12	.036	.0000	.22	1.1
July,	71	.25	.0004	.0071	.18	.033	.0000	.17	1.6
August,	68	.07	.0006	.0057	.23	.036	.0001	.09	1.6
September,	75	.12	.0002	.0056	.26	.038	.0000	.15	1.7
October,	62	.16	.0011	.0065	.27	.044	.0000	.14	1.8
November,	50	.20	.0008	.0082	.26	.046	.0000	.19	1.6
December,	42	.48	.0049	.0117	.25	.036	.0001	.34	1.1
Average,	55	.29	.0025	.0078	.22	.038	.0000	.22	1.4

Water from a Tap at Lawrence Experiment Station.

[Parts per 100,000.]

1900.	Temperature. Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
Jauuary,	44	.30	.0051	.0081	.37	.052	.0000	.23	2.0
February,	42	.38	.0027	.0089	.24	.043	.0000	.27	1.5
March,	41	.34	.0023	.0065	.16	.027	.0000	.24	1.4
April,	48	.28	.0005	.0062	.19	.032	.0000	.22	0.9
May,	51	.29	.0006	.0088	.13	.042	.0000	.25	1.0
June,	60	.25	.0003	.0059	.12	.035	.0000	.22	1.1
July,	69	.12	.0001	.0040	.18	.029	.0000	.16	1.6
August,	70	.06	.0002	.0045	.23	.038	.0000	.08	1.7
September,	72	.10	.0001	.0047	.26	.038	.0000	.11	1.6
October,	63	.12	.0006	.0053	.27	.041	.0000	.11	1.8
November,	58	.13	.0004	.0068	.26	.048	.0000	.18	1.5
December,	51	.41	.0022	.0105	.26	.033	.0000	.34	1.2
Average,	56	.23	.0013	.0067	.22	.038	.0000	.20	1.4

CONTINUATION OF AN INVESTIGATION

OF THE

ACTION OF WATER UPON METALLIC OR METAL-LINED SERVICE PIPES,

AND METHODS FOR THE SEPARATION AND DETERMINATION OF METALS IN WATER.

By HARRY W. CLARK, *Chemist of the Board*, and FRED B. FORBES, *Assistant Chemist*.

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Action of Water upon Metallic or Metal-lined Service Pipes,

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By Harry W. Clark, *Chemist of the Board*, and Fred B. Forbes, *Assistant Chemist.*

In the report of the Board for 1898 an article was given upon an investigation of the action of water upon certain metals of which many service pipes are made or with which they are lined, this investigation being undertaken because of the occurrence of many cases of lead poisoning in several of the towns and cities of the State having ground water supplies and in connection with which lead or lead-lined service pipes were largely used. This investigation has been continued during the past two years when opportunity offered, and we have now collected series of samples from a large majority of the towns and cities of the State where lead service pipes are used to any great extent. We have also made a number of experiments tending to give us information upon certain points in connection with the investigation, but, as they have generally simply confirmed previous experiments recorded in the former article, their results are not included here.

The results of the investigation up to the time of writing the report given in 1898 seemed to show that the cause of the taking of lead from the service pipes by the water of certain towns and cities was the presence of a considerable volume of free carbonic acid in the ground waters, which actively attacked lead, and further investigation has confirmed this conclusion. Many laboratory experiments during the past three years have shown that, while pure soft water, especially when containing some dissolved oxygen, attacks lead, and while the presence of coloring matter, free ammonia, nitrates and nitrites in soft water also causes considerable solvent action upon lead in laboratory experiments, yet, taking into consideration the

results of our entire investigation, we find that in actual practice, with the conditions prevailing in the service pipes of a distribution system, a potable water in Massachusetts to have any dangerous lead-dissolving action must contain considerable free carbonic acid. It is not sufficient, however laboratory experiments may result, that a water be simply soft or comparatively free from mineral matters in solution alone to enable it to take a dangerous amount of lead into solution from service pipes in actual use. This is shown by results of analyses of samples of water collected from lead service pipes in towns supplied with surface water, most of these surface waters being softer than the average ground water of the State, but nevertheless not attacking lead to any great extent. Neither is the presence of an abundance of oxygen in the water in a distribution system, except when free carbonic acid is also present, any considerable factor in dissolving lead from service pipes in actual use, as is shown by the analyses of the samples from surface water supplies, although in laboratory experiments the opposite sometimes seems to be the case. There are some indications that the composition of the mineral contents of a ground water may influence slightly its action upon lead, and also that any considerable quantity of oxide of iron, separating from the water and depositing in the service pipes, has sometimes an appreciable action upon the lead. These are minor influences, however. It was shown also in the first report that the greater the hardness of the water as compared with its free carbonic acid, the less effect did this carbonic acid have upon lead, and further investigation has confirmed this.

The tables given in the following pages summarize the work of the two years since the previous report, and it will also be noted that there are given in the tables, besides the results from towns and cities not before reported upon, further results from several of the towns and cities mentioned in the last report.

The first of these tables shows the maximum amount of lead found in any of the samples of water which have stood in the pipe over night, collected during the past two years from each town or city, together with the maximum amount found when the sample was taken during the ordinary daytime use of the water.

In Table No. 2 the results of analyses of the series of samples from each ground water supply examined during the past two years are given, this table being so arranged as to give the towns in the order of the greatest average amount of lead found in the series of

samples taken when the water was in ordinary daytime use. This table also gives the average length of the lead service pipes from which the samples were collected in each city or town, and the average diameter of these pipes, together with the average amount of free carbonic acid found in the water supply upon different dates and the hardness of the water of each supply. The average length and size of the lead piping at each place has really very little to do with the amount of lead found in the samples of water that have remained in the pipes over night, providing only that the pipe is of sufficient size and length to hold a gallon of water, the usual amount collected for analysis. On the other hand, the length of the pipe may have considerable influence upon the amount of lead found in the samples taken during ordinary daytime use, as the longer the pipe, the greater is the period of time that the water is in contact with lead before it reaches the faucet. These variations in length thus have some influence upon the amount of lead found in the samples of water taken during daytime use and should be taken into account when comparing the average amount of lead found in samples from two water supplies having practically equal amounts of carbonic acid and being very similar in other respects.

Table No. 3 arranges the surface water supplies examined during the past two years in the same manner as that in which the ground water supplies are arranged in Table No. 2. It will be noticed that Lawrence heads the list here, and the water supply of this city is in some respects similar to a ground water supply, — that is, it is a surface water filtered through a slow sand filter in which nitrification takes place and the production of carbonic acid occurs.

Table No. 4 gives a list of the ground water supplies arranged in order of the amount of free carbonic acid found in each supply. It will be noticed on examining this table that four of these supplies contain more than 3 parts per 100,000 of free carbonic acid, and that with one exception the amount of lead found in the samples taken during daytime use of the water at these four places, as shown by the averages given, is greater than that from any of the other cities and towns in the table. The exception is the third hardest water of the sixteen given in the table, and the samples taken were from comparatively short service pipes. The samples taken from this supply of water that had stood in the service pipes over night, however, show its great lead-dissolving power, the average amount found in these samples being greater than that in the samples from any

other supply with the exception of one, as shown by the table. Of the three supplies averaging more than 2 but less than 3 parts per 100,000 of free carbonic acid, all are of a sufficient degree of hardness to counteract any great action by the carbonic acid present in them, and one — the Cohasset supply — is the hardest of any of the waters given in the table. Nine of the waters in the table contain more than 1 and less than 2 parts of carbonic acid per 100,000, and none of these, as shown by the figures given, has any marked dissolving action upon lead, with the exception of the Boulevard well supply of Lowell and the Newton supply. It will be noted, however, that the Boulevard well water is the softest of any of these waters with the exception of the Webster water, and that the Newton samples were taken from service pipes averaging 179 feet in length, and that this water is also quite soft.

Tables Nos. 5 and 6 give the average amount of dissolved oxygen found in these waters, and show plainly that it has but slight effect in determining their lead-dissolving powers under practical conditions. Weymouth water, however, almost without hardness (see Table No. 3), takes considerable lead from the pipes when it is in contact with them for a considerable period of time, as shown by the average amount found in the samples of water that remained in the Weymouth service pipes over night.

Table No. 1.

List of Cities and Towns with Maximum Amounts of Lead found in Samples of Water taken during Ordinary Use and after Standing in the Pipe.

	Lead (Parts per 100,000).			Lead (Parts per 100,000).	
	During Ordinary Use.	After Standing in Pipe.		During Ordinary Use.	After Standing in Pipe.
Amesbury,	.0029	0.0043	Lowell, Boulevard wells,	.0800	0.4000
Andover,	.0171	0.0571	Lowell, Cook and Hydraulic wells.	.5143	0.4643
Attleborough,	.1714	0.1371	Marblehead,	.0086	0.0143
Beverly,	.0257	0.0314	Metropolitan supply,	.0400	0.1371
Bridgewater,	.0086	0.0171	Middleborough,	.3429	1.1429
Brookline,	.0114	0.0286	Needham,	.0171	0.0429
Cambridge,	.0086	0.0114	Newton,	.0714	0.1714
Cohasset,	.0086	0.0086	North Attleborough,	.0071	0.0329
Dedham,	.0100	0.0200	Norwood,	.0043	0.1371
Franklin,	.0286	0.1143	Webster,	.0200	0.0571
Grafton,	.0229	0.0457	Wellesley,	.0152	0.0314
Hyde Park, old wells,	.0457	0.4571	Weymouth,	.0800	0.2286
Hyde Park, new wells,	.0200	0.0457	Woburn,	.0229	0.0343
Lawrence,	.1371	0.1829			

Table No. 2.

Lead in Samples of Water.— Ground Waters, arranged according to Average Amount of Lead found when Water is in Ordinary Use.

[Parts per 100,000.]

	Lead (Average).	Average Length of Pipe (Feet).	Average Size of Pipe (Inches).	Free CO_2.	Hardness.	Locality.
In ordinary use, . .	.1608	79	¾	3.287	3.5	Lowell, Cook and Hydraulic wells.
After standing in pipe,	.2535					
In ordinary use, . .	.1549	123	¾	4.148	2.6	Middleborough.
After standing in pipe,	.6171					
In ordinary use, . .	.0697	95	1	3.242	1.7	Attleborough.
After standing in pipe,	.0905					
In ordinary use, . .	.0432	179	¾	1.187	2.2	Newton.
After standing in pipe,	.0908					
In ordinary use, . .	.0400	43	¾	3.243	4.6	Hyde Park, old wells.
After standing in pipe,	.3029					
In ordinary use, . .	.0202	62	¾	1.301	1.5	Lowell, Boulevard wells.
After standing in pipe,	.0861					
In ordinary use, . .	.0187	265	⅞	1.912	3.2	Grafton.
After standing in pipe,	.0329					
In ordinary use, . .	.0172	32	¾	2.773	2.9	Hyde Park, new wells.
After standing in pipe,	.0329					
In ordinary use, . .	.0101	98	¾	1.092	2.3	Wellesley.
After standing in pipe,	.0219					
In ordinary use, . .	.0100	76	¾	1.689	0.8	Webster.
After standing in pipe,	.0286					
In ordinary use, . .	.0091	112	¾	2.392	2.1	Needham.
After standing in pipe,	.0269					
In ordinary use, . .	.0082	230	¾	1.611	4.1	Dedham.
After standing in pipe,	.0150					
In ordinary use, . .	.0074	461	¾	1.149	4.7	Brookline.
After standing in pipe,	.0197					
In ordinary use, . .	.0057	127	¾	1.084	2.6	Bridgewater.
After standing in pipe,	.0143					
In ordinary use, . .	.0049	144	¾	1.529	2.9	North Attleborough.
After standing in pipe,	.0226					
In ordinary use, . .	.0048	39	1	2.411	6.3	Cohasset.
After standing in pipe,	.0043					

Table No. 3.

Lead in Samples of Water.— Surface Waters, arranged according to Average Amount of Lead found when Water is in Ordinary Use.

[Parts per 100,000.]

	Lead (Average).	Average Length of Pipe (Feet).	Average Size of Pipe (Inches).	Free CO_2.	Hardness.	Locality.
In ordinary use, . .	.0543	104	¾	1.100	1.6	Lawrence.
After standing in pipe,	.0704					
In ordinary use, . .	.0314	109	¾	0.152	0.3	Weymouth.
After standing in pipe,	.1167					
In ordinary use, . .	.0111	85	¾	1.105	1.3	Metropolitan supply.
After standing in pipe,	.0293					
In ordinary use, . .	.0108	122	¾	0.119	1.0	Andover.
After standing in pipe,	.0257					
In ordinary use, . .	.0087	84	¾	0.121	2.3	Beverly.
After standing in pipe,	.0147					
In ordinary use, . .	.0025	58	¾	1.225	2.7	Cambridge.
After standing in pipe,	.0064					

TABLE No. 4.

Lead in Samples of Water.— Ground Waters, arranged according to Amount of Free Carbonic Acid.

[Parts per 100,000.]

	Lead (Average).	Average Length of Pipe (Feet).	Average Size of Pipe (Inches).	Free CO_2.	Hardness.	Locality.
In ordinary use, . . After standing in pipe,	.1549 .6171	123	¾	4.148	2.6	Middleborough.
In ordinary use, . . After standing in pipe,	.1608 .2535	79	¾	3.287	3.5	Lowell, Cook and Hydraulic wells.
In ordinary use, . . After standing in pipe,	.0400 .3029	43	¾	3.243	4.6	Hyde Park, old wells.
In ordinary use, . . After standing in pipe,	.0697 .0905	95	1	3.242	1.7	Attleborough.
In ordinary use, . . After standing in pipe,	.0172 .0329	32	¾	2.773	2.9	Hyde Park, new wells.
In ordinary use, . . After standing in pipe,	.0048 .0043	39	1	2.411	6.3	Cohasset.
In ordinary use, . . After standing in pipe,	.0091 .0269	112	¾	2.392	2.1	Needham.
In ordinary use, . . After standing in pipe,	.0187 .0329	265	⅞	1.912	3.2	Grafton.
In ordinary use, . . After standing in pipe,	.0100 .0286	76	¾	1.689	0.8	Webster.
In ordinary use, . . After standing in pipe,	.0082 .0150	230	¾	1.611	4.1	Dedham.
In ordinary use, . . After standing in pipe,	.0049 .0226	144	¾	1.529	2.9	North Attleborough.
In ordinary use, . . After standing in pipe,	.0202 .0861	62	¾	1.301	1.5	Lowell, Boulevard wells.
In ordinary use, . . After standing in pipe,	.0432 .0908	179	¾	1.187	2.2	Newton.
In ordinary use, . . After standing in pipe,	.0074 .0197	461	¾	1.149	4.7	Brookline.
In ordinary use, . . After standing in pipe,	.0101 .0219	98	¾	1.092	2.3	Wellesley.
In ordinary use, . . After standing in pipe,	.0057 .0143	127	¾	1.084	2.6	Bridgewater.

TABLE No. 5.

Lead in Samples of Water.— Ground Waters arranged according to Amount of Dissolved Oxygen.

TOWN OR CITY.	LEAD (PARTS PER 100,000) (AVERAGE).		Oxygen Dissolved (Per Cent. of Saturation).
	Water in Pipes over Night.	Water in Daytime Use.	
Grafton,	.0329	.0187	86.0
Needham,	.0269	.0091	82.6
Bridgewater,	.0143	.0057	81.4
Hyde Park, new wells,	.0329	.0172	73.7
Wellesley,	.0219	.0101	63.2
Newton,	.0908	.0432	61.0
Webster,	.0286	.0100	50.0
Dedham,	.0150	.0082	48.6
North Attleborough,	.0226	.0049	34.6
Attleborough,	.0905	.0697	32.3
Middleborough,	.6171	.1549	24.0
Hyde Park, old wells,	.3029	.0400	23.0
Brookline,	.0197	.0074	15.5
Lowell, Boulevard wells,	.0861	.0202	13.2
Lowell, Cook and Hydraulic wells,	.2535	.1608	10.9
Cohasset,	.0043	.0048	9.7

TABLE No. 6.

Lead in Samples of Water.— Surface Waters arranged according to Amount of Dissolved Oxygen.

Town or City.	Lead (Parts per 100,000) (Average).		Oxygen Dissolved (Per Cent. of Saturation).
	Water in Pipes over Night.	Water in Daytime Use.	
Cambridge,	.0064	.0025	101.3
Beverly,	.0147	.0087	100.3
Weymouth,	.1167	.0314	87.0
Andover,	.0257	.0108	85.9
Metropolitan supply,	.0293	.0111	83.7
Lawrence,	.0704	.0543	52.7

Besides the samples analyzed to show the effect of the various ground and surface waters upon lead or lead-lined pipes in regard to the amount of lead taken from the pipes, a number of samples have also been examined during the last three years to show the effect of these waters upon pipes lined with zinc (galvanized iron), brass pipes, — from which both copper and zinc may be taken, — and pipes of block tin or iron pipes lined with tin, and tables following give the average results of these analyses. Service pipes of brass or tin are as yet but comparatively little used, in Massachusetts at least, and for this reason the number of samples examined of water that had been in contact with these metals was much smaller than the number from lead and galvanized-iron service pipes.

Table No. 7 shows the action of various ground water supplies upon galvanized-iron pipes in regard to the zinc taken from these pipes, this table giving not only the average amount of zinc found in the samples examined, but also the length and size of the pipes. In this table also determinations are given of the quantity of zinc found in samples of water taken from brass service pipes.

Table No. 8 gives like results from a few surface water supplies. These figures are not, of course, as significant as the figures giving the amount of lead taken from lead pipes, for, as far as known, the amount of zinc present in these waters as used is not sufficient to have any effect upon the health of the consumers of the water.

A number of samples have been examined of both ground and surface water supplies, to show the amount of copper taken from brass service piping; and Tables Nos. 9 and 10 give the average results, showing that most of these waters have very little power to attack the brass piping and take copper into solution.

Tables Nos. 11 and 12 give the average amount of tin found in various samples of both ground and surface waters, and it is evident that tin, like copper, is not attacked by these waters as easily as lead.

Table No. 13 gives the results of a series of samples collected on different dates from Oct. 19, 1899, to March 24, 1901, from a service pipe in Lowell, Mass., this service pipe consisting of 80 feet in length of iron pipe 4 inches in diameter, 75 feet in length of brass pipe 1½ inches in diameter, and 15 feet of brass pipe ¾ of an inch in diameter. There was also lead piping in the house, and, although the samples of water were taken from a faucet where the water was not supposed to have come in contact with this lead, yet, as lead was found in these samples, it is probable that by some means a small volume of each of the samples drawn had been in contact with the lead connections. The water supplied to this house was from the Boulevard wells, this water not having so great an action upon metals as the Cook and Hydraulic well supply. Examining the table, it will be noticed that the metal most readily taken from the brass pipe was zinc, and it was taken in increasing amounts from Dec. 24, 1899, to April 3, 1900, when the amount remained practically the same until July 10, 1900. There was also a regular increase in the amounts of iron and copper found in the various samples up to April 3, 1900, although but a small amount of copper was taken from the brass pipe. In the latter part of the year 1900 the brass pipe was changed for a tin-lined pipe, and the samples taken Feb. 10 and March 24, 1901, showed a very small amount of tin taken from this pipe by the water.

It has been found by tests made in the course of the investigation that lead pipe of different makes is acted upon somewhat differently by water, and the same can be said of the zinc coating of galvanized-iron pipes. This probably does not have an important influence upon the average results, however.

In general, the results of the entire investigation seem to show that the use of lead service pipes, especially in connection with ground water supplies containing considerable free carbonic acid, should be avoided wherever possible, and that, if a cement-lined iron pipe is not employed, a tin or properly constructed tin-lined pipe with a considerable thickness of tin is the safest and best for general use. It is evident that brass pipe is acted upon but slightly by most of the waters examined, but copper salts are considered to be more harmful than salts of tin.

TABLE NO. 7.

Zinc in Samples of Ground Water.

[Parts per 100,000.]

	Average.	Average Length of Pipe (Feet).	Average Size of Pipe (Inches).	Locality.
		Galv. Iron.		
In ordinary use, . . . After standing in pipe, .	1.8469 –	4,000	–	West Berlin.
In ordinary use, . . . After standing in pipe, . .	.3084 .7931	53	¾	Millbury.
In ordinary use, . . . After standing in pipe, . .	.1254 .5551	74	¾	Newton.
In ordinary use, . . . After standing in pipe, . .	.0857 .4914	65	⅝	Marblehead.
In ordinary use, . . . After standing in pipe, . .	.0733 .3257	117	¾	Grafton.
		Brass.		
In ordinary use, . . . After standing in pipe, . .	– .2867	40	¾	Lowell, Cook and Hydraulic wells.
In ordinary use, . . . After standing in pipe, . .	.0686 .2257	60	¾	Wellesley.
In ordinary use, . . . After standing in pipe, . .	.0527 .6686	–	–	Fairhaven.
In ordinary use, . . . After standing in pipe, . .	.0338 .1522	90	1⅛	Lowell, Boulevard wells.
		Galv. Iron.		
In ordinary use, . . . After standing in pipe, . .	.0286 .3628	100	½	Webster.
In ordinary use, . . . After standing in pipe, . .	.0000 .0000	40	–	Reading.
In ordinary use, . . . After standing in pipe, . .	.0000 .0000	Galv. Iron Cistern.	–	Warren.

TABLE NO. 8.

Zinc in Samples of Surface Water.

[Parts per 100,000.]

	Average.	Average Length of Pipe (Feet).	Average Size of Pipe (Inches).	Locality.
		Galv. Iron.		
In ordinary use, . . . After standing in pipe, . .	.8657 –	246	¾	Sheffield.
In ordinary use, . . . After standing in pipe, . .	.2900 .4280	–	–	Palmer.
In ordinary use, . . . After standing in pipe, . .	.2714 –	1,128	2	Beverly.
In ordinary use, . . . After standing in pipe, . .	.0070 .0103	49	⅝	Fall River.
		Brass.		
In ordinary use, . . . After standing in pipe, . .	.0000 .0000	92	1	Metropolitan supply.

Table No. 9.

Copper in Samples of Ground Water.

[Parts per 100,000.]

	Average.	Average Length of Brass Pipe (Feet).	Average Size of Pipe (Inches).	Locality.
In ordinary use, . . . After standing in pipe, . .	.0257 .0286	60	¾	Wellesley.
In ordinary use, . . . After standing in pipe, . .	.0076 .0233	90	1⅛	Lowell, Boulevard wells.
In ordinary use, . . . After standing in pipe, . .	– .0000	40	¾	Lowell, Cook and Hydraulic wells.

Table No. 10.

Copper in Samples of Surface Water.

[Parts per 100,000.]

	Average.	Average Length of Brass Pipe (Feet).	Average Size of Pipe (Inches).	Locality.
In ordinary use, . . . After standing in pipe, . .	.0000 .0470	20	⅝	Malden.
In ordinary use, . . . After standing in pipe, . .	.0050 .0000	92	1	Metropolitan supply.
In ordinary use, . . . After standing in pipe, . .	.0000 .0000	10	¾	Lawrence.
In ordinary use, . . . After standing in pipe, . .	– .0000	6	½	Wakefield.

Table No. 11.

Tin in Samples of Ground Water.

[Parts per 100,000.]

	Average.	Average Length of Pipe (Feet).	Average Size of Pipe (Inches).	Locality.
In ordinary use, . . . After standing in pipe, . .	.0371 .0286	80	¾	Dedham.
In ordinary use, . . . After standing in pipe, . .	.0043 .0172	90	–	Lowell, Boulevard wells.
In ordinary use, . . . After standing in pipe, . .	– .0112	–	–	Attleborough.
In ordinary use, . . . After standing in pipe, . .	– .0000	73	–	West Brookfield.

Table No. 12.

Tin in Samples of Surface Water.

[Parts per 100,000.]

	Average.	Average Length of Pipe (Feet).	Average Size of Pipe (Inches).	Locality.
In ordinary use, ...	–	45	–	Palmer.
After standing in pipe, . .	.0393			
In ordinary use, ...	.0186	50	¾	Malden.
After standing in pipe, . .	.0343			
In ordinary use, ...	.0404	100	⅝	Metropolitan supply.
After standing in pipe, . .	.0339			

Table No. 13.

Samples collected at a House in Lowell, Mass., where the Service Pipe was 80 Feet of 4-inch Iron + 75 Feet of 1½-inch Brass + 15 Feet of ¾-inch Brass, the Brass Pipe being changed afterwards to Tin-lined Pipe. — Boulevard Supply.

Date.		Parts per 100,000.				
		Lead.	Zinc.	Iron.	Copper.	Tin.
1899.						
Oct. 19,	After standing over night, ...	.0129	–	.0070	–	–
Oct. 19,	During ordinary use, ...	.0171	–	.0550	–	–
Dec. 24,	After standing twelve hours, . .	.0086	.0402	.0180	.0200	–
Dec. 23,	During ordinary use, ...	.0286	.0058	.0140	.0100	–
1900.						
Feb. 1,	After standing over night, ...	.0043	.1032	.0210	.0257	–
Feb. 1,	During ordinary use, ...	.0043	.0390	.0140	.0200	–
March 2,	After standing eleven hours, . .	.0036	.1429	.0320	.0314	–
March 1,	During ordinary use, ...	.0029	.0300	.0370	.0014	–
April 3,	After standing over night, ...	.0100	.2414	.0500	.0329	–
April 2,	During ordinary use, ...	.0057	.0243	.0220	.0129	–
May 4,	After standing over night, ...	.0057	.2357	.0200	.0300	–
May 3,	During ordinary use, ...	.0050	.0600	.0200	.0000	–
June 8,	After standing over night, ...	.0100	.2371	.0940	.0229	–
June 7,	During ordinary use, ...	.0071	.0286	.0190	.0000	–
July 10,	After standing some days, . . .	.0036	.1143	.0070	.0100	–
1901.						
Feb. 10,	After standing over night, ...	.0029	–	.0600	–	.0029
Feb. 9,	During ordinary use, ...	.0029	–	.0110	–	.0029
March 24,	After standing over night, ...	–	–	.0680	–	.0086
March 23,	During ordinary use, ...	–	–	.0190	–	.0000

Additional Experiments on Methods of Separation and Determination of Small Amounts of Lead, Zinc, Copper and Tin in Drinking Waters.

In analyzing samples of water drawn from house taps we frequently find more than one metal present in the water, due to the use of a different kind of pipe within the house from the service pipe. It thus becomes necessary to make a separation of the metals before it is possible to make a quantitative determination, and as in most cases the amount of each metal present in a gallon of water is very small, the problem of an accurate separation and determination is quite a difficult one. Lead, zinc and copper have frequently occurred together in a water, due to the use of lead and brass pipes, and we have succeeded in making a fairly accurate separation and determination of all three metals from the same sample of water. Tin we have met with as a rule alone, mostly in connection with experimental pipes of that metal, and so have not had to separate it from the other metals. The increasing use of tin as a lining for lead pipe, however, makes an accurate method of separation and determination desirable, and we are working along this line at present.

The method for the determination of lead as given in the report for 1898 has been continued in use, with quite satisfactory results. The standard solution of lead sulphate dissolved in ammonium acetate has been found to keep remarkably well; the strong solution made up at the beginning of our experiments, some four years ago, is still in use, recent gravimetric determinations showing no change in its strength. An attempt has been made in the treatment of waters containing iron to prevent the iron from precipitating out in alkaline solution with hydrogen sulphide by the addition of formic acid, and thus avoid the necessity of separating the lead as sulphate from the iron by alcohol, where considerable iron is present. This was found to work quite well when small amounts of iron were present, but with large amounts the method was unsatisfactory and it was abandoned.

We have endeavored to find volumetric methods applicable to the determination of small amounts of zinc, copper and tin, but without success. The very delicate color test for tin by means of ammonium molybdate, described by J. P. Longstaff in the "Chemical News"

for Dec. 15, 1900, has been tried, but owing to the uncertainty of the composition of our tin salts after concentration of a natural water, we have not yet obtained accurate quantitative results. Zinc has been determined satisfactorily by precipitating as sulphide and igniting to oxide, but the method for all the metals which has been most used is the method of electrolysis. An apparatus serving conveniently for this is constructed as follows: —

A hard rubber plate, 10 inches wide and 20 inches long, is provided with four insulated metal binding posts, each 2½ inches high, and carrying at the top a thumb-screw by which a coiled platinum wire electrode may be attached. In front of each post is a metal plate 2 inches square, covered with thin platinum foil, on which is placed an ordinary platinum evaporating dish of about 110 cubic centimeters capacity, the inside of the dish forming the opposite electrode. In front of each plate is a switch and at either end of the hard rubber plate a binding post for connection with the electric current. The wiring is on the under side of the rubber plate. Four determinations may be carried on simultaneously in four platinum dishes, and the wiring is so arranged that, by means of the switches, beginning at one end of the plate, either the first dish, the first two or the first three may be thrown in or out of the circuit at will, without interrupting the current through the remaining dishes. A cover with wooden sides and glass top fits closely over the whole apparatus, as a protection from dust, but may be easily lifted off to manipulate the dishes when desired. For the current, the ordinary Edison circuit of 110 volts is used. By means of four Edison lamps coupled in series and a water rheostat, the strength of the current may be varied within quite wide limits.

In most of the details of the electrolysis we have followed Classen as closely as possible. In dealing with such small quantities of the metals, however, the amounts of reagents used are in many cases of necessity more in proportion to the weight of metal present than is recommended in dealing with larger quantities. The following is an account of the technical details of the determination of each of the three metals, — zinc, copper and tin, — together with a record of experiments made with standard solutions of each. After this are given the methods of separation employed in the case of natural waters, and a series of experiments with natural waters to which various known amounts of the different metals have been added.

Zinc.

Two grams of pure metallic zinc were dissolved in dilute sulphuric acid and made up to one liter for a standard solution. For electrolysis, 4 grams of pure potassium oxalate and 3 grams of pure potassium sulphate are dissolved in water in a weighed platinum dish, the desired amount of zinc solution added, the volume made up with water within ¼ inch of the top, and the dish placed in the circuit on our apparatus, with a current of about .3 of an ampere, for three hours. The solution in the dish is siphoned out, and at the same time a stream of distilled water run into the dish while the current is still on, in order to expel the free sulphuric acid, which might dissolve some of the zinc if the current was broken at first. The current is then broken, the dish removed, washed with water from a wash bottle, then, with 95 per cent. alcohol free from residue, dried at 70° C., cooled and weighed. The following results were obtained with the standard solution: —

Weight of Zinc taken (Gram).	Weight of Zinc found (Gram).	Weight of Zinc taken (Gram).	Weight of Zinc found (Gram).	Weight of Zinc taken (Gram)	Weight of Zinc found (Gram).	Weight of Zinc taken (Gram).	Weight of Zinc found (Gram).
.0496	.0491	.0496	.0496	.0100	.0101	.0100	.0102
.0496	.0497	.0496	.0496	.0100	.0099	.0100	.0103
.0496	.0498	.0496	.0496	.0100	.0099	.0100	.0098
.0496	.0497	.0496	.0491	.0100	.0101	.0050	.0047
.0496	.0503	.0100	.0098	.0100	.0100	.0020	.0018
.0496	.0503	.0100	.0102	.0100	.0100	.0010	.0008
.0496	.0501	.0100	.0103	.0100	.0101		

With half the quantity of potassium oxalate and sulphate used in the previous experiments and recommended by Classen, standard solutions of zinc were electrolyzed with the following results: —

Weight of Zinc taken (Gram).	Weight of Zinc found (Gram).	Weight of Zinc taken (Gram).	Weight of Zinc found (Gram).	Weight of Zinc taken (Gram).	Weight of Zinc found (Gram).
.0050	.0052	.0080	.0081	.0100	.0101

In order to note the effect of an excess of ammonia salts, and to see if with such excess present the deposition of the zinc could be

accomplished with the reduced quantity of reagents, portions of 7.5 c. c. of concentrated sulphuric acid were diluted with water, nearly neutralized with ammonia, and standard solution of zinc added to each.

Weight of Zinc taken (Gram).	Weight of Zinc found (Gram).	Weight of Zinc taken (Gram).	Weight of Zinc found (Gram).	Weight of Zinc taken (Gram).	Weight of Zinc found (Gram).
.0040	.0043	.0060	.0060	.0060	.0059

Some difficulty was experienced in the zinc work in obtaining reagents which would give a perfect blank determination. In all cases blank determinations were run with each set of experiments, and corrections made in the results when necessary.

Copper.

A standard solution of copper was obtained by dissolving in nitric acid a weighed amount of pure copper, obtained by electrolyzing a solution of copper sulphate, and replacing the nitric acid by sulphuric acid. The solution was then made up to a definite volume. For electrolysis, to the solution of the copper salt 10 c. c. of concentrated sulphuric acid and 1 gram of urea are added, the solution diluted so as to nearly fill the dish, and electrolyzed for two hours with about .5 of an ampere current. The circuit is then broken, the dish washed with water, dried at 100° C., and weighed. The copper is then dissolved off the dish with dilute nitric acid (1 to 10), the dish washed again with water, dried at 100° C., and weighed. The difference in weight gives the copper.

Weight of Copper taken (Gram).	Weight of Copper found (Gram).	Weight of Copper taken (Gram).	Weight of Copper found (Gram).	Weight of Copper taken (Gram).	Weight of Copper found (Gram).	Weight of Copper taken (Gram).	Weight of Copper found (Gram).
.0104	.0102	.0042	.0041	.0020	.0021	.0010	.0009
.0052	.0054	.0042	.0043	.0020	.0017	.0005	.0005
.0042	.0044	.0026	.0026	.0010	.0012	.0000	.0000
.0042	.0040	.0021	.0021	.0010	.0009		

Separation of Copper by Urea in Presence of Zinc, and Effect of Urea in Subsequent Precipitation of the Zinc.

In order to see if small amounts of copper could be separated by the above method from a solution containing zinc, and the zinc subsequently determined in presence of the urea, the following experiments were tried: —

Portions of standard solutions of zinc and copper were mixed together, and 10 c. c. of strong sulphuric acid and 250 c. c. of 50 per cent. alcohol added, in order to duplicate the conditions which exist in an actual analysis after these metals are separated from lead. After concentrating sufficiently to expel the alcohol and reduce the volume to the capacity of the dish, 1 gram of urea was added, and the solution electrolyzed for copper. The solution with washings was neutralized with ammonia, made acid with acetic acid, and the zinc precipitated by hydrogen sulphide, ignited to oxide and weighed.

Number.	Weight of Copper taken (Gram).	Weight of Copper found (Gram).	Weight of Zinc taken (Gram).	Weight of Zinc found (Gram).
1, ...	.0063	.0060	.0200	.0201
2, ...	.0063	.0062	.0200	.0203

Portions of standard zinc solution, to each of which 1 gram of urea was added, were electrolyzed, with the following results: —

Weight of Zinc taken (Gram).	Weight of Zinc found (Gram).	Weight of Zinc taken (Gram).	Weight of Zinc found (Gram).
.0100	.0102	.0100	.0101

From these experiments it was concluded that small amounts of copper and zinc could be successfully separated by the urea method, and the zinc determined subsequently in the same solution, either by electrolysis or by precipitating as sulphide.

Tin.

A standard tin solution was made by dissolving 1 gram of pure metallic tin in 50 c. c. of strong hydrochloric acid in an Erlenmeyer

flask, with the addition of a bit of metallic platinum and without heat. This solution was then made up to 1 liter. For electrolysis, 10 c. c. of a saturated solution of acid ammonium oxalate is added to the solution of the tin salt previously made nearly neutral with ammonia in the weighed dish, the volume made up within ¼ inch of the top, and electrolyzed eight to ten hours, with about .3 of an ampere current. The dish is then removed from the plate, washed with water, then with alcohol, dried at 90° C., and weighed. Various experiments with different amounts of standard solution gave the following results : —

Weight of Tin taken (Gram).	Weight of Tin found (Gram).	Weight of Tin taken (Gram).	Weight of Tin found (Gram).	Weight of Tin taken (Gram).	Weight of Tin found (Gram).	Weight of Tin taken (Gram).	Weight of Tin found (Gram).
.0593	.0591	.0488	.0478	.0049	.0057	.0020	.0023
.0552	.0545	.0100	.0098	.0049	.0052	.0020	.0021
.0534	.0536	.0100	.0105	.0049	.0049	.0020	.0020
.0497	.0499	.0100	.0102	.0035	.0037	.0020	.0021
.0497	.0500	.0100	.0103	.0030	.0031	.0018	.0017
.0497	.0497	.0060	.0062	.0024	.0027	.0010	.0011
.0497	.0500	.0050	.0048	.0024	.0028	.0010	.0009
.0497	.0501	.0050	.0052	.0020	.0021	.0010	.0010

Method of Separation of Lead, Copper and Zinc.

In the analysis of natural waters the water is concentrated in a porcelain dish over a lamp, ammonium chloride added, and treated with ammonia and hydrogen sulphide, as in the method for lead. After standing some time, more ammonia and hydrogen sulphide are added, the contents of the dish boiled a few moments, and the precipitated sulphides filtered off. After washing with water containing ammonium chloride, the filter containing the precipitate is returned to the original dish and boiled with dilute nitric acid. The contents of the dish are then poured on a filter, washed with water, the filtrate evaporated to small bulk in a porcelain dish, 5 c. c. of concentrated sulphuric acid added, and the dish heated over a lamp until copious fumes of sulphuric acid come off. At this point, if no lead or copper is present, the contents of the dish are diluted slightly and an excess of ammonia added to precipitate iron. The filtrate is then made slightly acid with sulphuric acid, concentrated sufficiently,

potassium sulphate and oxalate added, and the solution electrolyzed for zinc under the same conditions as the standards.

If lead is present, however, the sulphates in the dish are diluted slightly with water and treated with about 150 c. c. of 60 per cent. alcohol, in order to render the lead sulphate insoluble. After standing some time the lead sulphate is filtered off, washed with 50 per cent. alcohol, dissolved in ammonium acetate, and the amount of lead determined as described in the 1898 report. If no copper is present, the filtrate from the lead is concentrated and a slight excess of ammonia added to precipitate iron. The filtrate from the iron is made slightly acid with sulphuric acid, and, after concentrating sufficiently, electrolyzed for zinc, as previously described. If copper is present, however, the filtrate from the lead is concentrated until the alcohol is expelled, and neutralized with ammonia. After filtering off any iron precipitate, 10 c. c. of concentrated sulphuric acid and 1 gram of urea are added, and the solution electrolyzed for copper, as in the case of the standard solutions, the zinc remaining dissolved in the strong acid. After the copper is all deposited, the all solution containing the zinc is treated with ammonia until nearly all the sulphuric acid is neutralized, when potassium sulphate and oxalate are added and the solution is ready to electrolyze for zinc. This solution, however, is generally saturated with ammonium salts due to neutralizing the 10 c. c. of sulphuric acid, and it is frequently impossible to get the zinc deposited firmly on the dish before the salts begin to crystallize out and interfere. To avoid this difficulty we have in some cases taken half of the solution, diluted it so as to nearly fill the dish, and electrolyzed. In other cases, the solution freed from the copper has been neutralized with ammonia, the zinc precipitated as sulphide in acetic acid solution, ignited to oxide and weighed.

The following table shows a series of results obtained on natural waters. In each case, two or three liters of the water, with the addition of various amounts of standard lead, zinc and copper solutions, were concentrated over a lamp, and the metals separated and determined as previously described. The amounts of zinc taken are in all cases considerably larger than the amounts of copper or lead. This is due to the fact that we have found generally that natural waters act upon zinc more energetically than upon the other metals, and we have experimented with such amounts of each metal present as we find in actual practice.

Number.	Lead.		Copper.		Zinc.	
	Weight taken (Gram).	Weight found (Gram).	Weight taken (Gram).	Weight found (Gram).	Weight taken (Gram).	Weight found (Gram).
1, ...	.0020	.0014	.0031	.0032	.0200	–*
2, ...	.0020	.0012	.0031	.0030	.0200	–
3, ...	.0005	.0003	.0005	.0003	.0020	–
4, ...	.0010	.0009	.0010	.0010	.0500	–
5, ...	.0015	.0012	.0031	.0029	.0300	–
6, ...	.0020	.0015	.0031	.0031	.0100	.0109
7, ...	.0020	.0016	.0031	.0030	.0100	.0105
8, ...	.0020	.0018	.0010	.0010	.0200	.0210
9, ...	.0020	.0018	.0010	.0013	.0200	.0204
10, ...	.0020	.0020	.0016	.0015	.0040	.0037
11, ...	.0025	.0027	.0016	.0015	.0200	.0194
12, ...	.0030	.0032	.0005	–	.0100	.0092
13, ...	.0040	.0045	.0010	.0010	.0060	.0058
14, ...	.0010	.0010	.0010	.0010	.0040	.0040
15, ...	.0015	.0013	.0020	.0025	.0100	.0096
16, ...	.0020	.0020	.0020	.0021	.0080	.0084
17, ...	.0025	.0024	.0010	.0012	.0200	.0196

* In the first five experiments the zinc was not determined; in the next four it was determined as oxide; in No. 10 all the zinc was deposited by electrolysis; while in the remaining experiments half the solution from which copper had been separated was electrolyzed for zinc, in order to avoid the separating out of ammonia salts, hence, any error in weighing is multiplied.

The Separation of Tin.

In the analysis of natural waters for small amounts of tin, several sources of error are met with, the most troublesome of which is the tendency of the tin salts to adhere to the dish after the concentration of the water. When the water acidified with hydrochloric acid is concentrated to small bulk, and hydrogen sulphide added to precipitate the tin as sulphide, it is very difficult to detach or even dissolve the sulphide precipitate from the sides of the dish, especially if the glaze be at all imperfect, and the subsequent results of electrolysis are frequently too low. To avoid this difficulty we have added caustic soda during the concentration, instead of hydrochloric acid. The tin is thus precipitated in easily soluble forms, whether it be present in the original water as a stannous or a stannic salt, and after the concentration is effected, hydrochloric acid is added to slight acidity. The solution of the precipitated salts is easily effected, and the dish remains bright and clean. Hydrogen sulphide is then added to precipitate the tin as sulphide, any iron present

remaining in solution. If no other metals are present, the tin sulphides are dissolved in strong hydrochloric acid, the solution made nearly neutral with ammonia, and electrolyzed.

A considerable but fairly constant weight is obtained in blank determinations by this method, due either to the caustic soda itself or to its action on the porcelain. The exact cause of this we are investigating at present. For the separation of tin from other metals, especially lead, we are experimenting with Classen and Bauer's method, of dissolving out the tin sulphide in sodium sulphide, converting to oxalate by means of hydrogen peroxide and oxalic acid, and electrolyzing.

AN INVESTIGATION

IN REGARD TO

THE RETENTION OF BACTERIA IN ICE

WHEN THE

ICE IS FORMED UNDER DIFFERENT CONDITIONS.

By HARRY W. CLARK, *Chemist of the Board.*

AN INVESTIGATION IN REGARD TO THE RETENTION OF BACTERIA IN ICE WHEN THE ICE IS FORMED UNDER DIFFERENT CONDITIONS.*

By Harry W. Clark, *Chemist of the Board.*

The question as to what constitutes a safe ice for domestic consumption is one of considerable importance, and difficult to satisfactorily answer. A chemical and bacterial examination of a cake of ice shipped to the laboratory, while satisfactory to the analyst as showing with considerable definiteness the character of this particular cake, may mean but little when considering the ice supply as a whole from which the cake was taken and the method in which it was harvested. A report showing this cake to be of an entirely satisfactory quality, and therefore the ice safe to use, is often exactly opposed to the opinion of the collector, who has examined the source of the ice supply in question and detected numerous chances of pollution, although this collector may know perfectly well that bacterial and chemical purification of water occurs during freezing. Just how great this purification is, under the varying conditions that must obtain in different ponds and rivers containing waters of a varying quality, has not been definitely known by us; neither has the difference in purification that occurs with ice formed in quiet water compared with ice that is formed in water moving with different degrees of rapidity. The following investigation was undertaken, however, with the hope of gaining some knowledge upon these points, and to show with more or less conclusiveness the various conditions under which water more or less polluted may be frozen and harvested and still furnish a satisfactory quality of ice.

The question is not a new one, an investigation and report upon it having been made by the Board in 1889.

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* A report to the Board March 20, 1901.

In the winter of 1899–1900 some experiments were made at the Lawrence experiment station in regard to the retention of bacteria in ice during the freezing of water, and additional experiments have been made during the winter of 1900–1901. Besides this, a considerable number of ice samples from various supplies in use have been examined, together with some work upon ice from ponds and rivers not used as sources of ice supply. In this work experiments have been made to determine the number of all kinds of water bacteria present in the water frozen which is retained in the ice when it is formed naturally, upon the surface of water, and also experiments upon the retention of B. coli and B. typhosus under like conditions. Experiments upon the retention of bacteria in ice when water in a comparatively small volume is frozen in a solid block have also been made. This second method of making ice is not that by which our natural ice supplies are formed upon ponds or lakes, although some artificial ice is formed in this manner, this ice, however, being formed generally from what is supposed to be a very pure water. The experiments upon freezing the entire volume of water held in a receptacle were chiefly, however, for the purpose of freezing as many bacteria as possible into ice, to determine their period of life under such conditions. The water used in the experimental work has varied from the filtered Lawrence supply, containing very little organic matter, to sewage containing a large amount of organic matter. A record of some of these experiments follows: —

Upon Feb. 26, 1900, two galvanized-iron pails of about three gallons' capacity were filled, one with sewage and the other with Merrimack River water, and placed outside the station. Upon February 27 the liquid in these pails had become frozen, and it was evident from inspection that this freezing took place by a layer of ice being formed first, not alone upon the surface water, but all around the interior of the pail and upon its bottom, this layer of ice gradually closing in. The outside ice of that frozen from sewage was quite clear, but towards the centre the ice contained the sewage sludge and in the centre was a very small volume of unfrozen sewage. The river water was frozen in the same way, except that the ice had cracked during freezing, and the last portion of the water had escaped from the cake without freezing. The number of bacteria and B. coli in the sewage and water before and after freezing follows: —

	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.
Sewage before freezing,	1,490,000	317,000
Sewage ice (outside of cake),	73,800	7,100
Sewage ice (inside of cake),	121,000	8,700
Unfrozen liquor in centre of cake of sewage ice,	637,000	52,000
River water before freezing,	8,200	32
River water ice (outside of cake),	138	0
River water ice (inside of cake),	131	0

At about this same date samples of ice were taken from the surface of three of our large outside filters receiving sewage, namely, Filters Nos. 1, 2 and 4. In each case there was very little sewage under the ice and in some places the lower portion of the ice touched the surface sand of the filters. No determination of the number of bacteria in the sewage applied to these filters was made, but our average sewage from which this ice was formed contains about 3,000,000 bacteria per c. c. The determinations of the bacteria in the ice resulted as follows: —

Ice from —	Thickness of Ice (Inches).	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.
Filter No. 1,	1	500	0
Filter No. 2, top ice,	3	10,100	0
Filter No. 2, bottom ice,		23,500	244
Filter No. 4,	–	21,500	250

Soon after, two tanks about 1 foot in depth and of a considerable surface area were placed outside the station, and upon March 2 one was filled with weak sewage and the other with Merrimack River water. By March 4 some ice had formed, but had afterwards partially melted, owing to warm weather. Upon the night of March 5 considerable snow fell, but the night was cold, and in the morning there was about ¾ of an inch of snow ice in the tanks over 2 inches of clear ice. Samples of the sewage and river water before freezing and samples of ice were taken from each tank for bacterial analysis, and showed the following results: —

	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.
River water before freezing,	7,100	17
River water ice, top of cake,	558	0
River water ice, bottom of cake,	124	0
Sewage before freezing,	500,000	4,100
Sewage ice, top of cake,	3,052	0
Sewage ice, bottom of cake,	6,600	0

These preliminary experiments in the winter of 1899–1900 showed, as was expected and as is well known, that when ice is formed naturally — that is, in the usual manner on the surface of still water — most of the bacteria are expelled from the water frozen and remain in the water below the ice and but a comparatively small number are retained alive in the ice. It was especially noticeable that no colonies of B. coli were found in the ice formed from either the weak sewage or river water in these shallow tanks. When sewage was frozen in a solid cake, however, while many bacteria were killed in the process of freezing, still, very many were retained and lived in the ice, and 1.6 per cent. of those in the river water were found in the ice formed in this way. As it seemed probable that the greater the depth of water under the ice in these experiments the less likelihood was there of bacteria being retained in the ice as it formed, and the nearer we should approach actual conditions in ponds and rivers, in January of the present year the experiments were continued, and deeper tanks were employed. For this purpose two galvanized-iron tanks, 28 inches in diameter and 6 feet deep, and one wooden tank, 28 inches in diameter and 4 feet deep, were set in the ground outside the station, the top of the tanks being only a few inches above the surface of the ground. Upon January 4 these tanks were filled as follows: one with sewage, one with river water, and one with the filtered river water (city water) and a mixture of cultures of B. typhosus and B. coli. Upon January 7 about 1½ inches of ice had formed on the iron tanks and about ¾ of an inch on the wooden tank, and on this date samples of the ice were taken, together with samples of the water under the ice, and examined with the following results: —

	Sewage Tank.		River Water Tank.		Tank containing Mixture of Water and Cultures.		
	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.	Bacteria per Cubic Centimeter.	B. Typhosus per Cubic Centimeter.	B. Coli per Cubic Centimeter.
Water under ice, . .	2,850,000	17,300	5,200	3	112	7	12
Ice, ...	187,000	7,600	58	0	15	0	0

Upon January 11 samples of ice were again collected for analysis from these tanks, these samples being of the new ice formed in the space from which ice was removed upon January 7, together with

one sample of the ice that had formed January 7. The results were as follows: —

	Sewage Tank.		River Water Tank.		Tank containing Mixture of Water and Cultures.		
	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.	Bacteria per Cubic Centimeter.	B. Typhosus per Cubic Centimeter.	B. Coli per Cubic Centimeter.
Water under ice,	2,000,000	53,000	36,600	5	1,157	0	0
New ice,	21,200	400	740	0	133	0	0
Old ice,	-	-	15	0	-	-	-

Upon January 16 all the ice was removed from the tanks, and they were refilled in exactly the same manner as on January 4. Samples were taken upon January 21, when about 4 inches of ice had formed, and again upon January 28, when the ice was about 6 inches in thickness. Results similar to those of the previous experiment were obtained on both dates in regard to the elimination of total numbers of bacteria, and B. coli was again found in the sewage ice but not in the river water ice; but the top ice from the tank in which the culture of B. typhosus was placed contained on January 21 a colony of this germ, and on January 28 two colonies were found in a second sample of top ice examined, but the bottom ice did not give a positive test. A third series of a like nature was started upon January 28, and the same results were obtained as with the first series, — that of January 4, — no B. typhosus or B. coli being found in the ice from the tank containing the mixture of cultures of these germs, and no B. coli in the ice from the tank containing the river water, although the water itself contained 263 colonies per c. c.

Upon February 5 the water was drawn from the tanks, and one of them was filled with a mixture of equal portions of river water and sewage and one with a mixture of 95 per cent. by volume of river water to 5 per cent. of sewage. Upon February 12 there were 6 inches in thickness of ice on these tanks, upon February 21 the ice was practically of the same thickness, and upon February 27 it had been reduced to about 3 inches in thickness. Examinations of the bacteria in the water in each tank when it was filled, of the water under the ice and of the top and bottom ice in each tank were made on these various dates, with the following results: —

	Sewage 50 Per Cent., River Water 50 Per Cent.		River Water 95 Per Cent., Sewage 5 Per Cent.	
	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.
Feb. 5, water in tanks,	370,000	22,000	15,000	263
Feb. 12, water under ice,	350,000	17,000	12,200	15
Feb. 12, top ice,	3,800	100	624	0
Feb. 12, bottom ice,	39,000	600	836	0
Feb. 21, water under ice,	570,000	7,000	8,500	5
Feb. 21, top ice,	1,500	42	137	7
Feb. 21, bottom ice,	14,000	230	366	2
Feb. 27, water under ice,	180,000	2,800	21,000	1
Feb. 27, top ice,	800	5	900	0
Feb. 27, bottom ice,	3,700	20	4,300	0

In this experiment with badly polluted water in each tank, although the degree of pollution differed largely, the bottom ice from each contained the greater number of bacteria. By increasing the ordinary pollution of the river water by the addition of 5 per cent. by volume of sewage, B. coli were retained in the ice formed from this water, and as would be expected a large number was found in the mixture of equal parts of river water and sewage.

Upon January 19 two volumes of water were frozen to a solid mass in two pails, as before described. The first was sewage, containing 9,000,000 bacteria per c. c. and 78,000 coli; the second was river water, containing 2,600 bacteria per c. c. and 115 coli. Examinations of this ice on different dates after its formation resulted as follows: —

	Sewage Ice.		River Water Ice.	
	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.
Jan. 21, top,	78,000	3,260	104	2
Jan. 21, centre,	90,000	2,915	143	8
Jan. 21, bottom,	1,193,000	8,100	603	0
Jan. 26, top,	283,000	2,200	3,000	0
Jan. 26, centre,	585,000	9,500	5,200	4
Jan. 26, bottom,	1,932,000	26,000	1,500	0
Feb. 4, top,	3,100,000	1,450	2,700	10
Feb. 4, centre,	2,100,000	3,100	21,500	10
Feb. 4, bottom,	912,000	7,500	22,000	6
Feb. 12, top,	483,000	1,300	10,200	0
Feb. 12, centre,	437,000	6,000	6,600	0
Feb. 12, bottom,	1,104,000	2,400	11,500	0
Feb. 19, top,	–	759	–	0
Feb. 19, centre,	–	1,539	–	0
Feb. 19, bottom,	–	1,477	–	2
Feb. 26, top,	900,000	1,700	13,900	8
Feb. 26, centre,	6,800,000	5,100	244,000	11
Feb. 26, bottom,	3,700,000	2,900	286,800	6

The number of bacteria and B. coli found in the ice at the times of examination on the dates given varied very greatly, and B. coli

were found in both the sewage and river water ice at the end of thirty-five days.

On February 16 cakes of ice were formed in the same manner in pails, one pail containing sterilized water and a culture of B. typhosus, and the other sterilized water and a culture of B. coli. The water seeded with the culture of B. typhosus contained 50 colonies per c. c., and the water seeded with B. coli contained 1,470 colonies per c. c. Samples were taken for examination from the top, centre and outside of each cake, upon February 26 and March 6, with the following results: —

	Ice from Typhoid Experiment (B. Typhosus per Cubic Centimeter).	Ice from B. Coli Experiment (B. Coli per Cubic Centimeter).
Feb. 26, top,	3	12
Feb. 26, centre,	2	16
Feb. 26, outside,	2	8
March 6, top,	0	0
March 6, centre,	0	144
March 6, outside,	0	4

The experiments made and the results here given are not all that have been made, but are illustrative of most of the work. As far as they go, they have seemed to show that, unless the water which is frozen is very rich in colonies of B. coli, these colonies are excluded from the ice during freezing if this ice is formed naturally. Differing results were obtained in the experiments with B. typhosus, and these results will be discussed farther along in this article. Our experiments have shown that some of the B. coli caught in the ice, when water is frozen in pails to a solid or nearly solid mass, as described, live for a number of weeks (see experiment of January 19); but the experiment (February 16) when B. typhosus was frozen into a solid block of ice seemed to show its disappearance at the end of eighteen days, although, of course, different results may be obtained upon further investigation, as its persistence in ice for a longer period has been noted.

Besides these experiments at the station, a number of samples of ice and water for chemical and bacterial examination have been taken from running water, such as the polluted Merrimack River, and from still water also polluted to a greater or less extent.

Upon January 22, and again upon February 20, series of samples of ice and water were collected from the Merrimack River at dif-

ferent points above Lawrence, between Lawrence and Lowell, and examined both chemically and bacterially, with the results given in the following tables. The samples were collected at the distances below the city of Lowell stated in the tables, — a city of 90,000 inhabitants emptying its sewage into this river.

Chemical and Bacterial Analyses of Merrimack River Water collected at Different Points between Lowell and Lawrence, January 22, 1901.

[Parts per 100,000.]

Distance below Lowell Dam. — Miles.	Appearance.			Odor.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.
	Turbidity.	Sediment.	Color.		Free.	Albuminoid. Total.	Albuminoid. In Solution.		Nitrates.	Nitrites.				
3	V. slight.	V. slight.	.36	V. slight.	.0088	.0168	.0134	.29	.017	.0001	.33	0.9	3,600	34
3½	V. slight.	V. slight.	.37	V. slight.	.0092	.0172	.0146	.28	.020	.0001	.33	0.9	3,500	55
4½	V. slight.	V. slight.	.37	V. slight.	.0098	.0200	.0156	.28	.020	.0002	.34	0.9	2,600	34
5½	V. slight.	V. slight.	.38	V. slight.	.0108	.0222	.0180	.32	.024	.0002	.40	0.9	5,400	53
6½	V. slight.	V. slight.	.35	V. slight.	.0090	.0218	.0156	.30	.021	.0002	.38	0.9	9,400	100
7½	V. slight.	V. slight.	.38	V. slight.	.0074	.0204	.0164	.28	.021	.0002	.37	0.8	1,000	35
8½	V. slight.	V. slight.	.35	V. slight.	.0074	.0190	.0168	.26	.021	.0002	.37	0.9	12,000	118

Chemical and Bacterial Analyses of Ice collected from the Merrimack River at Different Points between Lowell and Lawrence, January 22, 1901.

[Parts per 100,000.]

Distance below Lowell Dam. — Miles.	Total Thickness of Ice. — Inches.	Thickness of Snow Ice. — Inches.	Color.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.
				Free.	Albuminoid. Total.	Albuminoid. In Solution.		Nitrates.	Nitrites.				
3	2¾	1	.05	.0044	.0068	.0034	.02	.005	.0014	.10	0.1	36* 12	0
3½	5½	2⅛	.05	.0056	.0076	.0052	.02	.002	.0016	.12	0.1	8 4	0
4½	5¼	1¾	.07	.0050	.0072	.0038	.02	.006	.0006	.13	0.1	3 4	0
5½	5⅛	1½	.04	.0054	.0076	.0048	.02	.007	.0012	.08	0.1	26 11	0
6½	6	0	.05	.0050	.0070	.0046	.02	.005	.0014	.07	0.1	4 4	0
7½	6	0	.05	.0022	.0070	.0064	.03	.004	.0003	.05	0.2	1 5	0
8½	6⅜	⅜	.07	.0030	.0056	.0044	.02	.004	.0003	.04	0.2	32 4	0

* The upper figures give bacteria in the ice from the top of the cake and the lower figures bacteria in the ice from the bottom of the cake.

Chemical and Bacterial Analyses of Merrimack River Water collected at Different Points between Lowell and Lawrence, February 20, 1901.

[Parts per 100,000.]

Distance below Lowell Dam. — Miles.	Appearance.			Odor.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.
	Turbidity.	Sediment.	Color.		Free.	Albuminoid. Total.	Albuminoid. In Solution.		Nitrates.	Nitrites.				
3	V. slight.	V. slight.	.37	V. slight.	.0232	.0242	.0170	.28	.024	.0002	.44	1.2	2,500	237
3½	V. slight.	V. slight.	.40	V. slight.	.0350	.0324	.0236	.29	.034	.0004	.53	1.2	3,700	366
4½	V. slight.	V. slight.	.37	V. slight.	.0154	.0218	.0150	.28	.025	.0002	.41	1.2	3,800	150
5½	V. slight.	V. slight.	.34	V. slight.	.0160	.0218	.0158	.28	.024	.0002	.41	1.2	1,100	87
6½	V. slight.	V. slight.	.35	V. slight.	.0182	.0234	.0168	.27	.024	.0002	.42	1.2	2,400	123
7½	V. slight.	V. slight.	.35	V. slight.	.0174	.0220	.0182	.28	.021	.0002	.42	1.1	2,500	173
8½	V. slight.	V. slight.	.37	V. slight.	.0158	.0198	.0134	.28	.021	.0002	.39	1.1	2,400	87

Chemical and Bacterial Analyses of Ice collected from the Merrimack River at Different Points between Lowell and Lawrence, February 20, 1901.

[Parts per 100,000.]

Distance below Lowell Dam. — Miles.	Total Thickness of Ice. — Inches.	Thickness of Snow Ice. — Inches.	Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Bacteria in One Cubic Centimeter.	B. Coli per Cubic Centimeter.	
				Free.	Albuminoid.		Nitrates.	Nitrites.					
3	3½	3½	.10	.0102	.0194	.05	.004	.0007	.21	0.1	12	0	Average.
3½	8⅜	4½	.07	.0134	.0182	.04	.008	.0004	.30	0.1	21	0	Top of cake.
3½	8⅜	4½	.05	.0032	.0090	.00	.002	.0004	.08	0.0	2	0	Bottom of cake.
4½	6⅝	1⅝	.20	.0114	.0150	.04	.006	.0004	.27	0.1	8	0	Top of cake.
4½	6⅝	1⅝	.05	.0030	.0040	.00	.002	.0004	.04	0.0	5	0	Bottom of cake.
5½	7¾	1½	.09	.0090	.0106	.02	.004	.0002	.19	0.1	4	0	Top of cake.
5½	7¾	1½	.05	.0022	.0058	.00	.001	.0004	.06	0.0	3	0	Bottom of cake.
6½	10	1⅝	.05	.0140	.0088	.04	.003	.0002	.18	0.1	9	0	Top of cake.
6½	10	1⅝	.03	.0028	.0050	.00	.001	.0000	.04	0.0	1	0	Bottom of cake.
7½	5½	¼	.04	.0040	.0046	.01	.002	.0000	.07	0.1	16	0	Average of cake.
8½	6½	¼	.03	.0030	.0036	.01	.001	.0000	.06	0.1	1	0	Average of cake.

Upon March 1 samples of water and ice were collected from the Merrimack River at different points above the dam at Lowell and

from the ice houses from which a large portion of the ice supply of the city of Lowell is delivered, with the following results: the ice from the ice houses showed six colonies per c. c., and no B. coli. The cake examined was 10 inches in thickness of clear ice, the top of the cake having been planed at the time of harvesting. The chemical and bacterial analyses of the samples of water and ice collected by us from the river gave the following results: —

Chemical and Bacterial Analyses of Samples of Water and Ice from Merrimack River above Lowell Dam.

[Parts per 100,000.]

Location (Miles above Lowell Dam).	Total Thickness of Ice. Inches.	Thickness of Snow Ice. Inches.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.	
¼	-	-	.32	.0130	.0154	.0114	.24	.018	.0001	.30	1.0	38,600	25	Water.
¼	11	1½	.05	.0124	.0098	-	.03	.006	.0002	.11	0.0	3	0	Ice, top of cake.
¼	11	1½	.08	.0028	.0026	-	.01	.003	.0002	.03	0.0	6	0	Ice, bottom of cake.
2	-	-	.32	.0120	.0174	.0124	.24	.017	.0001	.31	1.0	4,000	21	Water.
2	11	2	.08	.0096	.0064	-	.03	.003	.0002	.08	0.0	4	1	Ice, top of cake.
2	11	2	.05	.0024	.0040	-	.01	.012	.0004	.04	0.0	15	7	Ice, bottom of cake.
4½	-	-	.33	.0090	.0152	.0102	.24	.021	.0001	.28	1.0	5,000	31	Water.
4½	11	4	.03	.0018	.0022	-	.01	.002	.0002	.03	0.0	*5 2	0	Ice, average of top and bottom of cake.

* The upper figure gives bacteria in the ice from the top of the cake and the lower figure bacteria in the ice from the bottom of the cake.

Besides these series of water and ice from the Merrimack River, seventeen samples of the ice, cut by the local ice dealers at Lawrence from the Merrimack River and delivered at the station (our ordinary supply), have been examined chemically and bacterially, but B. coli has not been found in any of them, although enough ice from each cake to equal 500 c. c. of water has been examined. The total number of bacteria present in them has averaged 8 per c. c.

Chemical and Bacterial Analyses of Ice as delivered at the Lawrence Experiment Station.

[Parts per 100,000.]

Date.	Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.
		Free.	Albuminoid.		Nitrates.	Nitrites.				
March 7,	.12	.0058	.0146	.02	.009	.0008	.11	0.0	13	0
March 14,	.02	.0034	.0040	.01	.001	.0002	.06	0.0	4	0
March 21,	.05	.0068	.0058	.00	.000	.0002	.11	0.0	7	0
March 28,	.07	.0082	.0046	.00	.002	.0002	.03	0.0	5	0
April 4,	.06	.0048	.0056	Lost.	.003	.0002	.03	0.0	1	0
April 18,	.06	.0042	.0052	.00	.006	.0002	.05	0.0	5	0
April 24,	.15	.0044	.0078	.00	.022	.0001	.04	0.0	22	0
May 2,	.03	.0056	.0032	.00	.002	.0002	.03	0.1	–	–
May 10,	.03	.0048	.0060	.00	.001	.0002	.03	0.0	2	0
May 17,	.10	.0138	.0108	.00	Lost.	.0002	.10	–	6	0
May 24,	.05	.0012	.0022	.01	.000	.0002	.03	0.0	5	0
May 29,	.02	.0020	.0032	.00	.002	.0004	.01	0.0	16	0
June 6,	.02	.0028	.0024	.01	.012	.0002	.02	0.0	11	0
June 13,	.03	.0028	.0040	.00	.004	.0000	.01	0.0	18	0
June 21,	.05	.0072	.0030	.00	.003	.0000	.04	0.0	4	0
June 28,	.02	.0034	.0058	.01	.002	.0001	.00	0.0	3	0
July 2,	.07	.0060	.0036	.02	.002	.0002	.12	0.0	–	0

A number of samples of ice taken from the Essex Company's canal, through which Merrimack River water flows, have been collected upon different mornings, when the ice has varied from ½ inch to 2 inches in thickness, and eight of the twenty-two samples examined have contained B. coli. The water in the canal flows at a much greater rate than the water in the river.

Samples of water and ice were collected upon February 27 from the Spicket River, into which much sewage flows, and which empties into the Merrimack River just below the experiment station. The samples were collected near sewer outlets, and it could be seen from inspection that considerable solid matter was frozen into the ice.

A number of samples of ice have also been taken from small ponds, some of which are considerably polluted, but no B. coli have been found in any of the samples of ice examined, and but very few bacteria of any kind.

Chemical and Bacterial Analyses of Miscellaneous Samples of Water and Ice.

[Parts per 100,000.]

Location.		Total Thickness of Ice. Inches.	Thickness of Snow Ice. Inches.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Bacteria per Cubic Centimeter.	B. Coli per Cubic Centimeter.
Pomps Pond, Andover,	Water.	-	-	0.59	0.0014	.0300	.0194	0.30	-	.0000	0.59	1.2	37	0
Pomps Pond, Andover,	Ice.	10	1¾	0.07	0.0056	.0044	-	0.01	.004	.0003	0.07	0.0	*1 4	*0 0
Holt's Pond, Andover,	Water.	-	-	0.61	0.0210	.1170	.0482	0.54	-	.0000	0.84	1.3	128	0
Holt's Pond, Andover,	Ice.	8¾	-	0.08	0.0088	.0134	-	0.01	-	.0002	0.14	0.0	5 1	0 0
Spicket River — Sample No. 1,	Water.	-	-	0.65	0.0576	.0336	.0264	0.88	.032	.0000	1.58	1.4	3,000	53
Spicket River — Sample No. 1,	Ice.	5	2½	0.18	0.0124	.0214	-	0.03	.009	.0004	0.25	0.2	100 100	1 -
Spicket River — Sample No. 2,	Water.	-	-	0.55	0.0320	.1008	.0316	0.84	.033	.0000	0.74	0.9	12,600	420
Spicket River — Sample No. 2,	Ice.	4½	1½	0.14	0.0406	.0208	-	0.03	.012	.0004	0.31	0.1	300 500	2 1
River water + 5 per cent. by volume of sewage,	Water.	-	-	1.34	0.3850	.0470	.0330	0.52	.006	.0000	0.48	-	20,800	150
River water + 5 per cent. by volume of sewage,	Ice.	-	-	-	0.0164	.0118	-	0.03	.004	.0002	0.13	0.0	900 4,300	0 0
Mixture of equal volumes of water and sewage,	Water.	-	-	1.30	3.4500	.2500	.1560	4.45	.009	.0000	1.96	-	180,000	2,800
Mixture of equal volumes of water and sewage,	Ice.	-	-	0.10	0.0976	.0200	-	0.07	.003	.0002	0.20	0.0	800 3,700	5 20

* The upper figures give bacteria or B. coli in the ice from the top of the cake and the lower figures bacteria or B. coli in the ice from the bottom of the cake.

Summary.

While the work so far carried on is not sufficiently complete to enable us to draw final conclusions, yet in a general way it indicates certain points that are of importance in the question of determining the safety of ice supplies. The power that water has of purifying itself by its transformation into crystals of ice is, of course, well known, and is characteristic of crystallization. Studying the chemical analyses of samples of water and the ice formed from this water as given in previous tables, we see that not only is a considerable percentage of the bodies in suspension in the water prevented from becoming embodied in the ice crystals formed, but also, what at first glance appears more remarkable, a larger percentage of the bodies in solution is thus prevented. Free ammonia, chlorides and the mineral salts that cause hardness are all partially or entirely driven from the water frozen into the water remaining unfrozen. Furthermore, it is evident that a substance such as ice, which in forming can free itself from the bodies in solution, must have the power to prevent bacteria — that is, bodies of a tangible size and in suspension — from becoming entangled within it, particularly if there is a considerable depth of water under the ice forming, and if these bacteria do not have a tendency to rise to the surface. That bacteria do not have this tendency is a well-proven fact.

Looking over our results, we find that in not one instance of the still freezing of ordinarily polluted water in our tanks or still water in the ponds examined have we been able to find B. coli in the ice formed. When freezing Merrimack River water in tanks, the average total number of bacteria of all kinds retained in the ice has been considerably less than 2 per cent. of the number in the water, and is a number averaging nearly as low as the average number we could expect in the effluent of a sand filter doing satisfactory work, and to which Merrimack River water was applied. B. typhosus has been retained in the ice twice out of four experiments made when this ice has been formed on still water containing cultures of this germ. These experiments were necessarily different, however, from those showing the elimination of total numbers of bacteria and B. coli, for here we were applying a laboratory culture of bacteria to the water. In doing this we necessarily passed to the water with this culture the media in which it was grown, and while the resulting

mixture was mainly a dilute solution of this media there may have been some particles present, inclosing germs, which were not completely eliminated in the process of freezing. The typhoid germ probably has no greater tendency to float than other bacteria.

When freezing sewage in our tanks, or Merrimack River water made more polluted by the addition of 5 per cent. by volume of sewage, B. coli together with a large number of other bacteria has been retained in the ice formed; that is, here we have exceeded the limits of the bacterial and organic pollution which the ice as it forms from the water and crystallizes can overcome. When ice is formed in swiftly running water as polluted as that in the Merrimack River, where sedimentation is overcome to a certain extent and there is a constant lateral or rolling movement of all the matter in suspension in the water, together with a tendency to prevent perfect crystallization because of this rolling movement, the danger of the retention of bacteria in the ice is much greater, as shown by the canal ice results. This ice was but just formed however at the time of examination while the ice from the river which was examined had been formed for perhaps several weeks and hence time enough had elapsed for many bacteria to die.

In none of the fourteen samples, however, of ice collected by us that had formed upon the comparatively slowly moving river water between Lawrence and Lowell, did we find B. coli, and the bacterial efficiency of freezing as shown by these samples even including the bacteria in the top ice of each cake was 99.78 per cent., that is, the ice contained only .22 per cent. of the number of bacteria in the water from which it was formed. Of the three samples of river ice collected by us from the river above Lowell, one contained B. coli, but, as has been stated, none of the samples of river ice delivered at the experiment station have contained B. coli, these samples of ice having been stored in an ice house, for periods varying from a few weeks to several months, before delivery at the station.

We have been able to show, however, that when ice is frozen in such a manner as to retain B. coli and B. typhosus, these germs will live for a number of weeks. The limit of their length of life when retained in ice, however, we have not determined, and are not sure that any single determination of this sort with cultures of B. typhosus would be of practical value, as it is well known that the virility of the germ in different cultures varies greatly, and very different

results might and probably would be obtained when experimenting with different cultures from different laboratories, or even from the same laboratory. It is evident that their period of life in ice is but a matter of a few weeks however. The period of time, however, that B. coli can live in ice formed when this germ is found naturally in the water we should be able to determine with considerable accuracy.

It is evident, however, from all our experiments, that, if the ice formed is not to contain any considerable number of bacteria of any kind, it must be formed in such a place that all of the water is not frozen, and the deeper and quieter the water under the layer of ice when forming, the less, probably, is the chance of bacteria being retained in the ice, this applying to ice formed upon both rivers and ponds. When, in order to thicken ice, the ice already formed on a pond or river is flooded and the entire volume of water over the ice is frozen, bacteria will undoubtedly be retained in this ice just the same as when the total volume of water in our pails was frozen, this point being distinctly brought out by the investigation and report of the Board upon this subject in the year 1889. It is also evident that the point then made, that the top ice should be planed and removed before cutting and storing, is of value not only on account of intentional flooding and of accidental flooding by a weight of snow on the ice, but also as there is a chance of many bacteria being frozen into the top ice at times of high wind when the first ice is forming. That is, the wind may stir the water to a considerable depth, overcoming sedimentation and the usual elimination of bacteria, and the water may wash over the ice as it forms.

On the whole, it is evident that the conditions surrounding water when it freezes are very important factors in determining the purity of the ice formed. If there is a considerable depth of water in portions of a somewhat polluted pond or river, and the ice is formed in these portions in comparatively quiet water, with but little matter in suspension, this ice will probably be entirely satisfactory for domestic use, although considerable drainage may enter the body of water upon which it forms. On the other hand, ice formed in shallow portions of such ponds or rivers, even during still weather, or in any portion if there is a considerable movement of the water by currents or wind while it is forming, may be rendered by these conditions entirely unfit for domestic use. The instances, however,

where the pollution of an ice supply are known to have caused disease are exceedingly rare. Lawrence is supplied very largely with ice cut from the Merrimack River, and yet since the construction of the city filter the typhoid death-rate of the city has been very low owing to the excellent quality of the city water. In former years, moreover, the epidemics of typhoid fever occurred during the winter rather than in summer when the consumption of ice is greatest.

STUDIES

OF THE

EFFICIENCY OF WATER FILTERS

IN

REMOVING DIFFERENT SPECIES OF BACTERIA.

By Stephen De M. Gage, *Biologist at the Lawrence Experiment Station.*

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Studies of the Removal of Water Bacteria.

In 1891 studies were made at the station of the relation between the different species of bacteria in the applied water and effluent of a filter receiving Merrimack River water, and from 1892 to 1897 cultures of various easily recognized species of bacteria, mainly *B. prodigiosus*, were applied to the different water filters from time to time, to test the efficiency of those filters in removing specific organisms. These latter tests were perhaps open to the criticism that the bacteria used as test organisms were not present in their natural state, having been under cultivation for some time, and tests of the filters with such organisms were possibly not the best standard of efficiency.

To study, however, the difference of the removal of different species *naturally present* in a water, frequent determinations were made of the different species in the applied water and effluents of Filters Nos. 68 and 69, during the period from Oct. 1, 1897, to April 30, 1898. These filters were receiving a water considerably more polluted than the Merrimack River water, and were run at a theoretical rate of 2,000,000 gallons per acre daily, Filter No. 68 being operated as an intermittent filter and Filter No. 69 as a continuous filter. No attempt was made, however, to study all of the different kinds of bacteria which might appear from time to time, but only those species which were fairly easy of recognition and differentiation, and which were commonly present in the applied water. In all, some twenty-six different species were found, but only twelve of these were present in the water throughout the investigation, and only these have been included in this discussion.

It will be noticed that in subsequent tables the species are designated by numbers instead of by names. This work has been one of comparative and quantitative species determination, rather than one of a detailed study of the species themselves; but, as far as they have been worked out, the numbers probably signify the species as indicated below: —

Number.	Species.	Number.	Species.
26, ...	*B. viridis.*	34, ...	*B. arborescens.*
27, ...	*B. fluorescens putidus.*	35, ...	*B. candicans.*
29, ...	*B. liquidus.*	39, ...	*B. fluorescens liquefaciens.*
31, ...	*B. subtilis.*	40, ...	*B. aurantiacus.*
32, ...	*B. liquefaciens.*	41, ...	*B. rubidus.*
33, ...	*B. mesentericus vulgatus.*	49, ...	*B. ærogenes.*

In making determinations, plates were made on nutrient gelatine and grown four days at 20° C. In case liquefaction threatened to destroy the count before the fourth day, the plates were transferred after the second day to a cold chamber, having a temperature of about 10° C., for the remainder of the period of incubation. Counts were made on the fourth day of the number of characteristic colonies of each kind, and a few of each kind were fished and put through the usual cultural tests, to confirm the diagnosis. In counting, only those colonies were included whose characteristics were well marked. Counting in this way, probably many immersed colonies, which were not characteristic, were omitted, but, as the same method was employed throughout the investigation on both applied water and effluents, the error was somewhere nearly constant and the results are comparable. The following table is a summary of the results during the whole period of the investigation: —

Summary of Species Tests on the Applied Water and Effluents of Filters Nos. 68 and 69.

Oct. 1, 1897, to April 30, 1898.	Applied Water.			Filter No. 68.				Filter No. 69.			
	Per Cent. of Samples in which the Species was found.	Seasonal Distribution of Species.*	Average Number of Bacteria per Cubic Centimeter.	Per Cent. of Samples in which the Species was found.	Seasonal Distribution of Species.*	Average Number of Bacteria per Cubic Centimeter.	Per Cent. of Bacteria removed.	Per Cent. of Samples in which the Species was found.	Seasonal Distribution of Species.*	Average Number of Bacteria per Cubic Centimeter.	Per Cent. of Bacteria removed.
Bacteria, ...	100	- -	61,700	100	- -	365.00	99.41	100	- -	261.00	99.58
Species No. 25, . . .	24	O., N., D., J., F., M.,	411	18	O., D., J., F., M.,	0.90	99.78	21	O., D., J , F.,	2.40	99.42
27, . . .	69	D., J., F., M., A.,	7,967	70	O., J., F., M., A.,	32.00	99.60	71	N., D., J., F , M.,	24.24	99.70
29, . . .	24	N., D., J., F., M., A.,	311	30	N., D., F., M., A.,	3.20	98.97	21	N., D., J., M., A.,	8.88	97.14
31, . . .	96	All,	2,256	98	All,	19.00	99.16	93	All,	9.69	99.57
32, . . .	60	All,	622	50	All,	4.13	99.34	33	N., D., F., M., A.,	3.21	99.48
33, . . .	16	O., D., J., A.,	111	18	N., J , F., M.,	5.25	99.57	17	N., D., M.,	0.31	99.72
34, . . .	20	O., D., J., F.,	122	13	J., M.,	0.15	99.88	7	J., A.,	0.14	99.89
35, . . .	11	D., F., M., A.,	211	3	N.,	0.03	99.99	5	D., A.,	0.95	99.55
39, . . .	40	All,	782	35	N., D., J., F., M.,	18.28	97.66	33	O , N., D., J., F., M.,	7.67	99.02
40, . . .	53	All,	833	28	N., D , J., F., M., A.,	1.08	99.87	33	N., D., J., F., A.,	3.24	99.61
41, . . .	16	N., D., A.,	178	20	O., N., D., A.,	3.15	98.23	17	O., N., D., M.,	0.67	99.62
49, . . .	36	D., J., F., M.,	1,589	23	D., J., F., M.,	2.05	99.87	33	D., J., F., A.,	1.60	99.90

* The months in which each species was found are indicated by their first letter.

From this table it is seen that the intermittent filter showed a somewhat greater distribution of species, and, with all but four species, a slightly poorer efficiency than the continuous filter. Towards three different species the average efficiency dropped below 99 per cent. These filters were small, however, and the surface disturbance from the intermittent method of operation was probably exaggerated for this reason. On the other hand, the efficiency of the continuous filter in every instance but one was above 99 per cent. In both filters the efficiency was highest toward the species Nos. 27, 31, 32 and 40, these being the more common and more widely distributed kinds.

These results would indicate that the efficiency of filters as shown by test cultures formerly used is not much different from the efficiency as shown by the species naturally present in a water.

Experiments on the Significance of B. coli in Filtered Water.

In the filtration of a water polluted by city sewage, two conditions may exist, — the germs *B. coli* and *B. typhi* may be present in greater or less numbers at all times in the applied water, or there may be periods when *B. coli* only is present. In order to throw some light on the relative behavior of *B. coli* and *B. typhi* when undergoing filtration, the experiments described beyond were made, and for these experiments the duplicate filters, Nos. 68 and 69, were chosen. These filters had been in operation for about four years and contained at the time the experiment was started about 30 inches in depth of sand. The filters were operated at the same rate and in the same manner as during the time when studies of species were made.

The filters were operated (1) with water containing both *B. coli* and *B. typhi*, to show the relative removal of the two species by the filters; (2) with water containing large numbers of *B. coli* followed by periods when this organism was absent, to show the persistence of the germ in a filter; and (3) with water containing large numbers of *B. typhi*, followed by periods of non-infection, to show the time required to eliminate this organism from the filter.

1. *Filtration of Water containing both B. coli and B. typhi.*

From June 11 to June 24 the filters were operated with filtered city water, to which broth cultures of *B. typhi* were added. Dur-

ing this period the typhoid bacillus was found in but four samples of the filtered water, two from each filter, and in one sample from each its presence was probably due to the fact that an unusually large number of the germs had been applied to the filters. During this time the filters each removed about 98 per cent. of all the bacteria from the applied water, notwithstanding the fact that they were running with a water which had already undergone filtration, and they had an efficiency of about 99.5 per cent. in the removal of the typhoid germs.

From June 25 to August 1 the filters were operated with Merrimack River water, to which a broth culture of *B. typhi* was added. After July 15 the numbers of *B. coli* naturally present in the applied water were increased by the addition of broth cultures of *B. coli*. During this period the typhoid bacillus was found in but one sample of the filtered water and *B. coli* was found in fourteen samples; the efficiency of the filters for the period being 98.75 per cent. for the total bacteria, 99.80 per cent. for the *B. coli*, and nearly 100 per cent. for the *B. typhi* applied.

On July 16 the filters were scraped and then raked 1 inch deep.

Following this, *B. coli* appeared in a few samples from the intermittent filter, but was not found in the effluent from the continuous filter, and *B. typhi* was not found in either effluent.

In the following tables will be found the results of daily analyses of the applied water and effluents during the above periods: —

Average Daily Number of Bacteria and B. typhi per Cubic Centimeter in the Applied Water and Effluents of the Filters when run with Water containing Typhoid.

1900.	Applied Water.		Filter No. 68.		Filter No. 69.	
	Bacteria.	*B. typhi.*	Bacteria.	*B. typhi.*	Bacteria.	*B. typhi.*
June 11,	72	13	24	0	30	0
12,	806	454	14	0	13	0
13,	546	281	5	0	5	0
14,	1,992	1,152	9	0	4	2
15,	162	10	9	14	9	0
16,	–	–	–	–	–	–
17,	–	–	–	–	–	–
18,	–	–	–	–	–	–
19,	126	14	18	0	12	0
20,	414	114	12	0	9	0
21,	2,980	54	26	1	18	3
22,	193	14	6	0	5	0
23,	310	140	34	0	7	0
Average,	760	225	16	1.5	11	0.5
Per cent. removed,	–	–	97.89	99.33	98.55	99.78

Average Daily Number of Bacteria, B. coli and B. typhi per Cubic Centimeter in the Applied Water and Effluents of the Filters when run with Water containing both Typhoid and B. coli.

1900.	Applied Water.			Filter No. 68.			Filter No. 69.		
	Bacteria.	*B. coli.*	*B. typhi.*	Bacteria.	*B. coli.*	*B. typhi.*	Bacteria.	*B. coli.*	*B. typhi.*
June 25,	8,900	97	24	6	0	0	5	0	0
26,	2,800	76	16	4	0	0	6	0	0
27,	3,100	140	70	11	0	0	26	0	0
28,	2,400	34	67	6	0	0	12	0	0
29,	-	-	-	-	-	-	-	-	-
30,	-	-	-	-	-	-	-	-	-
July 1,	-	-	-	-	-	-	-	-	-
2,	1,800	2	17	65	0	0	13	0	0
3,	2,800	42	163	76	0	0	89	1	0
4,	-	-	-	-	-	-	-	-	-
5,	-	-	-	-	-	-	-	-	-
6,	2,400	199	23	26	0	0	386	0	0
7,	1,400	35	23	34	0	0	199	0	0
8,	4,000	228	188	19	0	0	210	0	0
9,	-	-	-	-	-	-	-	-	-
10,	1,400	35	23	680	0	0	370	0	0
11,	14,000	228	188	852	0	0	27	0	0
12,	21,100	51	223	327	2	0	16	0	0
13,	-	-	-	-	-	-	-	-	-
14,	-	-	-	-	-	-	-	-	-
15,	-	-	-	-	-	-	-	-	-
16,	-	-	-	-	-	-	-	-	-
17,	1,400	31	182	26	1	0	12	0	0
18,	3,500	43	718	72	3	0	14	0	0
19,	22,200	270	480	24	0	0	56	0	0
20,	4,500	380	330	16	4	0	10	0	0
21,	2,900	7	12	19	0	0	10	2	0
22,	-	-	-	-	-	-	-	-	-
23,	-	-	-	-	-	-	-	-	-
24,	23,200	4,176	460	19	0	0	160	0	0
25,	3,800	338	473	4	0	0	54	0	0
26,	500	81	352	16	6	0	130	4	0
27,	21,100	1,540	700	7	0	0	24	0	5
28,	-	-	-	-	-	-	-	-	-
29,	-	-	-	-	-	-	-	-	-
30,	5,700	464	280	3	1	0	15	2	0
31,	26,500	3,749	1,470	8	0	0	26	11	0
Average,	7,900	524	282	101	0.74	0	81	0.96	0.22
Per cent. removed,	-	-	-	98.72	99.86	100	98.82	99.81	99.92

2. *The Persistence of B. coli in a Filter.*

From April 12 to April 15, 2.5 per cent. by volume of sewage was added to the water applied to the filters, and a broth culture of *B. coli* was mixed with the water. On April 16 city water was turned on and the filters were run with water free from *B. coli* until April 25. By this time all *B. coli* had disappeared from the effluents of the filters. From April 26 to May 12, the filters were flooded with a water containing 5 per cent. of sewage, no *B. coli* other than those naturally present in the sewage being added. Beginning May 13 the filters were again run with water free from *B. coli* until that organism was no longer found in the effluents. Dur-

ing this period, dissolved oxygen was at times not present in the effluent from the continuous filter, No. 69, but was always present in the effluent from the intermittent filter, and this accounts for the poor efficiency of the continuous filter.

In the following table will be found the results of daily bacterial analyses during this portion of the experiments: —

Average Daily Number of Bacteria and B. coli per Cubic Centimeter in the Applied Water and Effluents of the Filters when the Applied Water occasionally contained Large Numbers of B. coli.

1900.	Applied Water.		Filter No. 68.		Filter No. 69.	
	Bacteria.	*B. coli.*	Bacteria.	*B. coli.*	Bacteria.	*B. coli.*
April 12,	138,600	43	21	0	761	32
13,	96,800	80	28	0	1,277	14
14,	20,400	28	27	0	2,856	8
15,	–	–	–	–	–	–
16,	2,600	2,600	31	0	3,091	26
17,	16	0	32	0	2,639	7
18,	11	0	29	0	958	2
19,	–	–	–	–	–	–
20,	9	0	22	0	187	1
21,	18	0	20	0	288	1
22,	–	–	–	–	–	–
23,	23	0	20	0	55	0
24,	27	0	18	0	30	0
25,	29	0	14	0	38	0
26,	36,500	2,300	76	4	122	0
27,	102,200	18,900	44	2	19	0
28,	209,000	4,400	27	1	84	0
29,	–	–	–	–	–	–
30,	295,900	8,500	98	0	213	3
May 1,	103,000	1,400	1,289	2	2,777	60
2,	365,700	2,900	728	24	3,987	20
3,	108.400	4,700	117	2	4,435	48
4,	108,700	5,100	106	0	2,790	24
5,	147,100	110,200	93	0	2,894	85
6,	–	–	–	–	–	–
7,	325,900	76,000	31	0	3,472	8
8,	241,900	6,600	116	0	3,788	288
9,	227,300	6,900	366	19	6,975	187
10,	371,600	11,800	166	0	14,300	795
11,	187,200	6,300	93	0	8,900	806
12,	428,400	12,500	92	0	5,300	306
13,	–	–	–	–	–	–
14,	17	0	133	2	5,800	96
15,	10	0	40	0	2,200	26
16,	9	0	99	0	1,100	19
17,	27	0	26	0	566	0
18,	24	0	38	0	987	2
19,	7	0	41	0	394	1
20,	–	–	–	–	–	–
21,	18	0	33	0	210	0
22,	8	0	27	0	123	0
23,	22	0	3	0	9	0
24,	29	0	11	0	23	0
25,	12	0	9	0	9	0

3. *The Persistence of B. typhi in a Filter.*

From August 15 to August 25 the filters were operated with city water free from typhoid and *B. coli.* On August 15 and 16 and on August 21 and 22 strong cultures of *B. typhi* were mixed with the

applied water. These cultures were sufficiently strong to ensure the passage of the typhoid germs into the filter, as indicated by their appearance in the effluents. In both instances *B. typhi* appeared in the effluents in some numbers on the days when it was added to the applied water, but disappeared as soon as the application was stopped.

In the following table are given the average daily analyses of the applied water and effluents during this portion of the experiments. The total number of bacteria in the applied water was only slightly greater than the number of typhoid germs, and the number of water bacteria was not materially reduced during filtration, consequently these have been omitted from the table.

Daily Number of B. typhi in the Applied Water and Effluents of the Filters when the Applied Water occasionally contained Large Numbers of B. typhi.

	B. typhi per Cubic Centimeter in Applied Water.	*B. typhi* per Cubic Centimeter in Effluent of Filter No. 68.	*B. typhi* per Cubic Centimeter in Effluent of Filter No. 69.
August 15,	56,800	7	3
16,	10,800	6	18
17,	0	0	0
18,	0	0	0
19,	0	0	0
20,	0	0	0
21,	2,300	23	13
22,	14,300	11	10
23,	0	0	0
24,	0	0	0
25,	0	0	0
26,	0	0	0

Résumé.

In the foregoing, the following facts are noted: —

B. coli was found in the effluents of the filters more frequently than was *B. typhi*, although both germs were present in the applied water under about the same conditions.

After scraping the filters, *B. coli* appeared in the effluent of one of the filters, but *B. typhi* was not found in either effluent.

The number of *B. coli* and *B. typhi* in the applied water during

this experiment was much larger than would ordinarily be present in a water likely to be filtered for drinking purposes, and for this reason the tests of the filter were excessive.

B. typhi is not persistent in a filter, but is eliminated as soon as it ceases to be applied; but, on the other hand, *B. coli* may, under certain conditions, appear in the effluents for a short time, although not present in the applied water.

From the above we would conclude that *B. coli* is the more hardy germ of the two and that *B. typhi* would not be as apt to be found under the same conditions as the test organism *B. coli*.

NOTE.—During all of the experiments frequent tests were made for both *B. coli* and *B typhi* in 100 cubic centimeters of water, and in no case was either germ found in 100 cubic centimeters when it was not also found in 1 cubic centimeter.

EXAMINATION OF SPRING WATERS.

EXAMINATION OF SPRING WATERS.

In the year 1891 an examination was made by the State Board of Health of the various springs from which water was sold in considerable quantities for drinking purposes in the State, and a description of the springs, together with the results of chemical and bacterial analyses of samples of water from each, was presented in the annual report of the Board for that year. The number of springs examined at that time was 45. The number has now greatly increased, and during the year 1900 a second examination has been made of the various springs in the State from which water is sold for drinking, following in general the method of examination employed at the previous time. In making the investigations each spring has been visited, the surroundings inspected and the method of collecting and distributing the water observed. It was found that about one-third of the springs in use in 1891 had been discontinued, but 70 new ones have been added, so that there are 99 now in use, and the results of the examinations of the surroundings of these springs and of the analyses of their waters are given in tables appended hereto.

No attempt has been made to examine waters used for making soda water or effervescent drinks, except in cases where the water is sold both in carbonated form and in its natural state, and no attempt has been made to secure samples of water from springs outside of the State, though waters from some such springs are sold within the limits of the State.

In general, the water of the different springs is sold in the nearest city or town, but the waters of some of the springs are sold in many of the larger cities and towns throughout the State. The number of different spring waters sold in the various cities and towns is shown by the following table. In the case of the waters of certain springs sold in several places only the place in which the principal sales are made is given.

Boston,	30	Wakefield,	4
Somerville,	14	Worcester,	4
Cambridge,	11	Braintree,	3
Malden,	11	Brookline,	3
Everett,	9	Cohasset,	3
Brockton,	8	Gloucester,	3
Lowell,	8	Milton,	3
Lawrence,	7	New Bedford,	3
Medford,	7	Scituate,	3
Lynn,	6	Beverly,	2
Melrose,	6	Framingham,	2
Natick,	6	Hull,	2
Chelsea,	5	Middleborough,	2
Springfield,	5	Newton,	2
Winchester,	5	Randolph,	2
Winthrop,	5	Revere,	2
Arlington,	4	Weymouth,	2
Quincy,	4	Whitman,	2
Stoneham,	4		

It will be seen from this table that a very large spring water business is done in Boston and in the adjacent cities and towns. Outside of the metropolitan water district the largest consumers of spring waters are Cambridge, Brockton, Lowell, Lawrence, Lynn, Natick and Springfield.

The principal cause of the large and increasing use of spring waters appears to be the desire to obtain a water that is of good appearance and free from taste and odor. Nearly all of the surface waters used for the supply of cities and towns in the State have at times a noticeable color and taste or odor, and many of them are sometimes rendered very disagreeable for drinking, particularly in the summer season, from these causes. Where such conditions exist, though there may be no reason to suspect that the water is unsafe for drinking, large quantities of spring waters are sold and used by the people, and among the largest sales of spring waters are those which are made to the operatives and employees in factories and stores in Lynn, Brockton and other places where the public water supply is often objectionable for drinking in the summer season from the causes stated.

Another frequent cause is fear that the public water supply may not be safe for drinking, and in some cities and towns supplied with ground water nearly free from color, taste and odor, large quantities of spring water have been used for this reason. In the city of Lowell, where much spring water has been used, the public

supply is drawn from ground-water sources, but some of these sources, used until very recently, supplied water which acted rapidly on the lead service pipes through which it was distributed, making the water dangerous for drinking on account of the quantity of lead it contained.

At Lawrence the public water supply, taken from the Merrimack River, is filtered through a sand filter for the removal of disease germs, and in this process a considerable portion of the color, and generally all of the taste and odor, are removed, but the water is subsequently passed through an open distributing reservoir in which microscopical organisms grow sometimes in large numbers in the summer season, and the water then acquires a noticeable taste and odor.

It has been found impracticable to obtain wholly reliable data as to the quantity of spring water sold in the different cities and towns, so that the amount can only be estimated approximately. The total sales reported from the various springs amount to about 6,500,000 gallons in a year, or an average of 65,000 gallons per year from each spring. The largest sales from any spring were found to be about 930,000 gallons per year. The sales of two others were approximately 500,000 gallons per year; of another 437,000 gallons, and of two others between 300,000 and 350,000 gallons. The sales from these six springs amount to nearly half the total quantity of sales reported from all of the springs.

The price charged for spring water was found to range generally from two cents per gallon to twenty cents per gallon, though in one case the price was as high as seventy-five cents per gallon. The average price per gallon of the water sold amounts to about five cents. In some cases water is supplied to factories at a certain price per person, the operator of the spring agreeing to keep the drinking water tanks continually filled, and allowance is made for this method of supply in the price above given. The total amount of money paid for spring water in the State during a year, using the figures for the amount of water sold and the price per gallon as ascertained from the operators of the various springs, is about $325,000.

The methods of collecting and distributing the spring waters evidently have a considerable influence upon their quality. At many of the springs basins or reservoirs for receiving the water as it flows from the ground have been constructed with great care, and in many cases the sides of the reservoir have been extended above the surface

of the ground and so constructed as to prevent the entrance of surface water. Spring houses have been built over many of the springs which prevent the entrance of polluting matters from the top and also prevent deterioration of the water by its exposure to light. In other cases the spring is left in its natural state, or the waters are collected in a loosely stoned-up basin unprotected from surface water, and in some cases situated where cattle are allowed to drink from the spring. Of the springs examined 63 were so arranged as to effectually prevent pollution from surface water or by animals, and so covered that foreign matter could not enter from the top. Of the remaining springs, 23 were so arranged as to make pollution in these ways unlikely, while 13 were not protected in any way from surface pollution.

The most common method of distributing the water is by means of bottles or carboys, the bottles ranging in capacity from two quarts to three gallons, while the carboys usually have a capacity of five gallons each. Large quantities are also distributed from tanks, this method being commonly adopted where water is sold to factories for drinking purposes. A small quantity of water is also sold in jugs and in tin cans.

There is a great difference in the method of filling the receptacles in which the water is distributed. In some cases the appliances are very crude and the receptacles themselves are either dipped directly into the water of the spring or are placed upon the edge of the spring and filled from it by means of a pail or dipper, the water spilled in the process being allowed to run back into the spring either directly or over the surface of the ground. In other cases the process of filling the bottles is conducted with care and every precaution is taken to prevent the pollution of the water of the spring in the process. In most of these cases the water is conveyed in pipes to a bottling room, situated at a considerable distance from the spring, and the receptacles are filled from faucets in this room. In 60 out of the 99 springs examined the method of filling the receptacles was such that no contamination of the water of the spring is likely in the process, while in the remainder sufficient care is not taken to avoid danger of polluting the spring.

In very few cases has any method of cleaning the bottles or other receptacles been adopted other than rinsing them in water from the spring. In cases where a bottle becomes noticeably dirty it is some-

times cleaned with warm water and soda, and is sometimes scoured by means of shot or a chain, but generally only at infrequent intervals. In one case the bottles are not only thoroughly cleaned, but are subjected to a high temperature supposed to be sufficient to kill any bacteria before the bottles are filled with the water.

In the course of the examination two samples of water have been collected from nearly all of the springs for chemical and bacterial analysis, and two additional samples have been collected from the receptacles in which the water was being distributed to consumers. Difficulty has been experienced in securing satisfactory samples of water for bacterial analysis, so that in many cases the number of bacterial determinations is less than the number of chemical analyses.

The results of the chemical examination have shown in some cases a considerable difference between the quality of the water as it was found to be at its source and as delivered for use. This is caused in some cases by the addition of some mineral ingredient to the water, but in most cases by lack of care in its collection and distribution.

The results of the bacterial examinations of the different spring waters show that in general the waters of unpolluted springs protected from the light and from the entrance of surface water are practically free from bacteria, just as are the properly protected ground waters used for public water supplies in the State; but upon comparing the bacterial analyses of the waters as taken from the springs with the bacterial analyses of these waters as delivered to consumers it will be seen that generally there is a very great increase in the number of bacteria in the water between the time the water leaves the spring and the time that it is delivered to the consumer, while in the case of the public water supply taken from a ground-water source, the water (if the works are properly constructed) is delivered into the houses of the consumers in the same condition as when drawn from the ground. The great increase in the numbers of bacteria noted in the spring waters as delivered to consumers over the numbers found in the sources is probably due, in part, to the exposure of the water to conditions favorable to the growth of bacteria, but this increase is doubtless very largely due, in most cases, to lack of care and cleanliness in its collection and distribution.

In cases where the number of bacteria was determined tests were also made to determine the presence or absence of the *colon bacillus*, and this organism was found to be present in a number of instances both in sources of supply and in the water as distributed.

In order that a water may be safe for drinking it is of the highest importance that the source shall be free from pollution by the wastes of human life. Other considerations are of secondary importance, and in the classification of the waters, in this as in the previous report, this consideration has been given the greatest weight. It was found, early in the investigations of water supplies by the Board, that all of the waters of the State contained naturally some chlorine, the quantity being greatest near the sea-shore and diminishing as the distance from the coast increases. It was also found that when chlorine in excess of the normal was present in a water this excess was in proportion to the population on the water-shed from which the water was derived. The accumulated results of observations for many years show that the quantity of chlorine in an unpolluted water in any locality may vary considerably from month to month and from year to year, and in determining the normal chlorine of a source it is necessary to take such variations into consideration.

An examination of the water-shed and surroundings of each of the springs under consideration has been made and these circumstances considered in connection with the results of the analyses. It is often difficult, in the case of a ground water, to determine very definitely the area from which the water is derived, and there is sometimes a question whether a possible source of pollution near the limits of the apparent water-shed of a spring or well affects the quality of the water or not.

The results of all the analyses are presented in three groups in the tables which follow. In the first group of analyses those waters only are included in which the chlorine of the water collected from the source is normal, or if in excess of the normal the excess does not exceed 0.1 of a part per 100,000. This table includes 37 of the 99 springs examined. The second group includes those springs in which the chlorine is in excess of the normal from 0.11 to 0.30 parts per 100,000; it contains 19 waters. In the third group of 43 springs the chlorine varies from an excess of 0.31 parts per 100,000 to an amount so large as to indicate that the waters are mainly filtered sewage.

The fact that the chlorine is in excess of the normal in these springs does not show necessarily that their waters are unfit for drinking. In many of these cases the source of pollution is remote from the spring and the well-known purifying power of the soil is a safe-guard against any unpurified organic matters and their accompanying bacteria finding their way into the waters. Even where the pollution is great and the sources near to the spring, the purifying power of the soil may be sufficient to prevent polluting matters from entering the springs in an unpurified state and rendering their waters dangerous to health; but in the case of such springs there is the possibility not infrequently realized that a change in the circumstances attending the pollution of the water may at any time result in unpurified matters reaching the spring.

In considering the waters having chlorine in excess of 0.1 above the normal these waters have been divided into two groups. One of these groups (Group 2) contains the waters in which the excess of chlorine is small, ranging from 0.10 to 0.30 parts per 100,000 above the normal. The sources of pollution which were unfavorably affecting the quality of these waters were in nearly all cases located at such a distance from the springs that the danger of serious pollution was remote, and in those cases in which sources of pollution were found near the spring there was evidence that the direction of the movement of the ground waters in the neighborhood at the time the examinations were made was such that these pollutions were not very seriously affecting the quality of the spring water.

The remaining group (Group 3) contains all of those waters in which the excess of chlorine is greater than 0.30 parts per 100,000, and in nearly all of these cases the sources of pollution are either near the spring or so numerous as to have a very marked effect upon the quality of the water.

The samples in which the *colon bacillus* was found to be present are indicated in the tables. In nearly all of these cases it seems probable that this bacillus was introduced into the water by lack of care in protecting the spring from pollution or in the collection and distribution of the water.

Water containing the *colon bacillus*, the presence of which is evidence of the presence of fæcal matter, must be regarded as unsafe for drinking. While the presence of this organism may be, in any particular instance, accidental (and in only one case has it been found

to be present in more than one sample from any source), it is, nevertheless, probable that more frequent analyses covering a longer time might show that it is often present in these waters and that it is present at times in the waters of other springs. The presence of this organism in so many samples examined is an evidence of the danger involved in the use of spring waters where the source is not thoroughly protected and the water collected and delivered in such a way as to preclude the danger of pollution.

In arranging the waters in the different groups consideration has been given to their quality in other respects than that shown by the chlorine contents. It is desirable, for instance, to avoid the use of very hard waters or waters high in mineral contents. It is also of importance that a drinking water should be free from organic matter. The arrangement of the waters in the tables has, therefore, been made upon the relative degree of freedom from mineral and organic contents at the source.

Following the tables will be found a brief description of each spring and its surroundings and water-shed so far as determinable, together with a statement as to the manner of collecting and distributing the water.

In nearly all cases the spring waters examined have been derived from natural springs where the ground water flows to the surface, but in some cases these waters are taken from the ground by means of wells or collecting works. There is no essential difference between ground water which flows from the earth in the form of a spring and ground water drawn therefrom by means of tubular or other wells or collecting galleries, such as are used in the collection of water on a large scale for a public water supply, and for this reason it is not to be expected that there would be any material difference between the purest of the spring waters sold in the various cities and towns and the purest of the waters of public water supplies collected from the ground by means of large works and distributed in a proper manner.

The results of the investigation show, by comparing the best of the spring waters with the best of the public water supplies taken from the ground, that there is no essential difference between them, and that the water supplied to the people of Mansfield, Tisbury, Walpole and many other places through faucets in their houses is equal in quality to the best spring waters found in the State. Fur-

thermore, a comparison of the quality of the various ground water supplies in the State with that of the spring waters examined shows that, on the whole, the quality of such public supplies is naturally much better than that of the spring waters.

Nothing is to be gained, therefore, by the use of spring waters in cities and towns where the public water supply is drawn from a good ground-water source and is supplied through appropriate works. Water from such a public supply, and nearly all public ground-water supplies in the State are of this class, is not exposed to danger of contamination, while spring waters are, as a rule, exposed to serious danger of pollution, either at the source or in the process of collection and delivery to consumers.

Following is a list of springs examined, arranged alphabetically by towns, giving also the normal chlorine of the locality and the pages on which the analyses and description, respectively, will be found: —

Town.	Spring.	Analyses (Page).	Description (Page).	Normal Chlorine. (Parts per 100,000.)
Abington,	Highland,	558	576	0.43
Amesbury,	Lombard,	552	569	0.45
Andover,	Ballardvale Lithia,	549	564	0.24
Arlington,	Robbins,	556	573	0.28
Belmont,	Belmont Crystal,	561	580	0.29
Belmont,	Belmont Natural,	553	570	0.28
Belmont,	Trapelo,	560	579	0.29
Boston,	Undine,	562	583	0.32
Braintree,	Monatiquot,	549	565	0.57
Brockton,	Brockton Crystal,	563	583	0.38
Brockton,	Brockton Mineral,	557	575	0.39
Brockton,	Granite Rock,	558	577	0.38
Brockton,	Indian,	550	566	0.39
Chelmsford,	Golden Cove,	551	568	0.20
Chelmsford,	Robin's Hill,	557	575	0.21
Chelsea,	Mt. Washington,	559	578	0.50
Concord,	Concord,	551	567	0.22
Danvers,	Lakoo Indian Crystal,	559	578	0.39
Danvers,	Sager's,	554	571	0.39
Dracut,	Baltic,	552	569	0.18
Duxbury,	Myles Standish,	560	579	2.45
Easton,	Simpson,	551	568	0.34
Everett,	Belmont Hill,	564	585	0.45
Everett,	Everett Crystal,	563	584	0.45
Fall River,	Banquet,	549	565	0.40
Fitchburg,	Pearl Hill Mineral,	559	577	0.13
Framingham,	Hamilton Mineral,	563	584	0.24
Framingham,	Nobscot Mountain,	550	566	0.23
Franklin,	Sunnyside,	554	571	0.27
Gloucester,	Magnolia,	554	571	1.20
Gloucester,	Niagara,	556	573	1.00
Gloucester,	Ravenwood,	549	565	1.14
Haverhill,	Smiley's,	561	581	0.28
Hingham,	Mount Blue,	551	567	0.70
Holbrook,	Mingo,	563	584	0.45

Town.	Spring.	Analyses (Page).	Description (Page).	Normal Chlorine. (Parts per 100,000.)
Lawrence,	Bodwell,	557	575	0.24
Lawrence,	Hygiene,	562	582	0.27
Lawrence,	Knowles' Diamond,	558	576	0.27
Lawrence,	Stevens,	560	580	0.25
Lawrence,	Valpey's,	553	570	0.27
Lexington,	Katahdin,	561	581	0.25
Lexington,	Larchmont,	564	585	0.26
Lexington,	Lexington,	563	584	0.27
Lowell,	El Azhar,	549	564	0.18
Lowell,	Highland,	562	582	0.20
Lowell,	Leland,	561	581	0.21
Lowell,	Mt. Pleasant,	555	572	0.20
Lynn,	Electric,	555	573	0.50
Lynn,	Lovers' Leap,	561	581	0.50
Lynnfield,	Deep Rock,	562	582	0.31
Malden,	Linden Mineral,	560	579	0.42
Mattapoisett,	King Philip's Mineral,	552	569	0.60
Medford,	Fulton Natural,	550	567	0.35
Medford,	Middlesex Mountain,	553	570	0.35
Mendon,	Miscoe,	550	565	0.23
Methuen,	Abbott's,	551	568	0.26
Methuen,	Burnham,	558	576	0.23
Methuen,	Crystal Mineral,	557	575	0.23
Middleborough,	Nemasket,	551	567	0.45
Millbury,	Howe's,	552	568	0.18
Milton,	Farrington Silver,	549	565	0.40
Milton,	Milton,	560	580	0.50
Natick,	Lang Moore,	552	568	0.26
Natick,	Leland,	552	569	0.26
Natick,	Maher's,	562	582	0.27
Natick,	Pequot,	560	580	0.27
Needham,	Bird's Hill,	556	574	0.29
New Bedford,	Howland,	557	575	0.58
North Brookfield,	Quabaug,	550	566	0.13
Norwood,	Norwood,	553	570	0.30
Pepperell,	Pepperell,	550	566	0.14
Quincy,	Puritan,	559	577	0.48
Quincy,	Shawmut,	555	572	0.43
Revere,	Columbia Lithia,	556	574	0.60
Scituate,	Beaver Dam,	555	572	0.80
Scituate,	Egypt,	559	578	0.80
South Hadley,	Mt. Holyoke Lithia,	553	570	0.11
Springfield,	Hygeia,	561	580	0.11
Springfield,	Ingersoll Grove,	559	578	0.11
Stoneham,	Beach Hill,	556	573	0.30
Stoneham,	Bear Hill Mineral,	563	585	0.30
Stoneham,	Chapman Crystal Mineral,	562	583	0.30
Stoneham,	Middlesex Fells,	555	572	0.32
Stoneham,	Vishnu Mineral,	553	570	0.30
Sutton,	Calumet Mineral,	551	567	0.20
Swampscott,	Bassett's,	563	583	0.70
Swampscott,	Moose Hill,	564	584	0.70
Tewksbury,	Clark's Ledge,	557	576	0.22
Wakefield,	Montrose,	558	577	0.32
Westford,	Nashoba,	559	578	0.18
West Springfield,	Massasoit,	554	571	0.11
Weymouth,	Avonia,	560	579	0.61
Weymouth,	Garfield,	554	571	0.62
Whitman,	Goulding's,	558	576	0.44
Whitman,	Whitman,	561	582	0.46
Wilbraham,	Wilbraham Mountain,	556	574	0.12
Williamstown,	Sand,	552	569	0.06
Winchester,	Fairmont,	556	574	0.28
Woburn,	Silver Seal,	555	572	0.28

Group I.

Normal Spring Waters and those in which the Excess of Chlorine above the Normal is not more than .10 Parts per 100,000.

Lowell, El Azhar Spring.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
				Free.	Albuminoid.		Nitrates.	Nitrites.				
33191	Oct. 4, 1900, from spring,	.02	2.40	.0000	.0010	0.14	.0020	.0000	.00	0.3	.0420	14
34595	Jan. 28, 1901, from spring,	.02	2.50	.0004	.0010	0.18	.0030	.0000	.00	0.8	.0110	3
33192	Oct. 4, 1900, as sold, .	.06	2.40	.0006	.0010	0.14	.0020	.0000	.02	0.6	.0350	–
34596	Jan. 28, 1901, as sold, .	.02	2.30	.0008	.0018	0.18	.0030	.0000	.00	0.5	.0050	12

Andover, Ballardvale Lithia Spring.

33088	Sept. 26, 1900, from spring,	.00	2.50	.0000	.0006	0.23	.0040	.0000	.00	0.5	.0020	4
34445	Jan. 14, 1901, from spring,	.00	2.20	.0006	.0018	0.24	.0030	.0000	.02	0.3	.0180	355
33139	Sept. 25, 1900, as sold, .	.10	22.40	.0002	.0022	–	.0040	.0000	.11	0.0	.0080	–
34473	Jan. 15, 1901, as sold, .	.02	21.00	.0022	.0058	–	.0080	.0000	.12	0.2	.0020	31,500

Gloucester, Ravenwood Spring.

35480	Apr. 22, 1901, from spring,	.00	3.30	.0000	.0018	1.14	.0030	.0000	.01	0.8	.0100	3
35481	Apr. 22, 1901, as sold, .	.00	3.30	.0022	.0018	1.14	.0020	.0000	.01	0.8	.0080	144,000

Fall River, Banquet Spring.

33328	Oct. 19, 1900, as sold, .	.00	2.70	.0006	.0018	0.38	.0010	.0000	.02	0.0	.0040	25,100

Milton, Farrington Silver Spring.

32693	Aug. 28, 1900, from spring,	.00	3.50	.0000	.0016	0.37	.0030	.0000	.01	0.3	.0020	33
34604	Jan. 29, 1901, from spring,	.00	3.40	.0006	.0024	0.44	.0030	.0000	.01	0.5	.0060	0
32694	Aug. 28, 1900, as sold, .	.00	3.80	.0004	.0020	0.41	.0030	.0000	.03	0.5	.0040	9,800
34324	Jan. 2, 1901, as sold, .	.00	3.00	.0046	.0038	0.45	.0040	.0000	.01	0.3	.0080	26,300

Braintree, Monatiquot Spring.

33364	Oct. 19, 1900, from spring,	.02	4.00	.0000	.0004	0.57	.0050	.0000	.00	0.8	.0080	–
34317	Jan. 2, 1901, from spring,	.00	4.00	.0002	.0012	0.57	.0050	.0000	.01	0.8	.0040	0
33365	Oct. 19, 1900, as sold, .	.02	3.70	.0000	.0006	0.58	.0030	.0000	.00	0.5	.0080	13,200
34318	Jan. 2, 1901, as sold, .	.00	3.90	.0004	.0022	0.56	.0060	.0000	.01	0.8	.0040	10,300

Normal Spring Waters and those in which the Excess of Chlorine above the Normal is not more than .10 Parts per 100,000 — Continued.

Mendon, Miscoe Spring.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
33314	Oct. 16, 1900, from spring,	.00	4.20	.0000	.0006	0.18	.0010	.0000	.00	1.4	.0040	–
34312	Jan. 1, 1901, from spring,	.00	3.10	.0002	.0022	0.20	.0040	.0000	.01	0.5	.0090	11
33288	Oct. 12, 1900, as sold,	.00	4.30	.0004	.0010	0.19	.0050	.0000	.01	1.3	.0030	4,100
34759	Feb. 14, 1901, as sold,	.00	3.50	.0004	.0016	0.22	.0040	.0000	.01	0.2	.0020	43,200

North Brookfield, Quabaug Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
33342	Oct. 18, 1900, from spring,	.00	3.50	.0000	.0006	0.14	.0110	.0000	.01	0.8	.0070	–
34612	Jan. 28, 1901, from spring,	.00	3.90	.0000	.0010	0.14	.0380	.0000	.00	1.0	.0050	473
33343	Oct. 18, 1900, as sold,	.00	3.50	.0004	.0014	0.12	.0060	.0000	.01	0.6	.0100	14,100
34597	Jan. 28, 1901, as sold,	.01	3.10	.0012	.0020	0.13	.0580	.0001	.00	1.0	.0040	115,900

Framingham, Nobscot Mountain Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32974	Sept. 18, 1900, from spring,	.00	4.30	.0000	.0010	0.21	.0040	.0000	.00	1.3	.0040	33
33917	Dec. 3, 1900, from spring,	.02	3.30	.0000	.0040	0.23	.0090	.0000	.02	2.0	.0070	7
33026	Sept. 20, 1900, as sold,	.00	3.90	.0004	.0024	0.21	.0050	.0000	.00	1.4	.0040	–
33899	Dec. 3, 1900, as sold,	.02	3.70	.0010	.0034	0.23	.0070	.0000	.01	1.7	.0060	22

Brockton, Indian Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
L. 28722	Sept. 12, 1900, from spring,	–	9.70	.0002	.0006	0.28	.0414	.0000	.00	0.7	.0060	48
34057	Dec. 12, 1900, from spring,	.00	3.00	.0002	.0014	0.39	.0100	.0000	.01	0.5	.0040	2
L. 28731	Sept. 13, 1900, as sold,	–	6.50	.0002	.0008	0.29	.0414	.0000	.01	0.7	.0140	730
34058	Dec. 12, 1900, as sold,	.00	2.90	.0020	.0024	0.39	.0080	.0000	.01	0.6	.0070	285

Pepperell, Pepperell Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
33380	Oct. 22, 1900, from spring,	.02	5.40	.0000	.0006	0.15	.0090	.0000	.00	2.3	.0030	–
34295	Dec. 31, 1900, from spring,	.00	5.20	.0006	.0006	0.14	.0040	.0000	.01	2.6	.0050	7
33359	Oct. 18, 1900, as sold,	.00	6.30	.0000	.0010	0.15	.0010	.0000	.02	2.3	.0060	3,800
34296	Dec. 31, 1900, as sold,	.01	5.40	.0000	.0008	0.13	.0040	.0000	.02	2.6	.0080	52,600

Medford, Fulton Natural Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32457	Aug. 13, 1900, from spring,	.00	4.20	.0002	.0038	0.34	.0080	.0000	.02	1.8	.0020	140
33715	Nov. 19, 1900, from spring,	.00	5.00	.0000	.0014	0.37	.0120	.0000	.01	2.1	.0030	23
32487	Aug. 14, 1900, as sold,	.00	3.80	.0000	.0008	0.33	.0100	.0000	.02	1.7	.0050	12,000
33787	Nov. 23, 1900, as sold,	.00	4.60	.0006	.0026	0.37	.0150	.0000	.00	2.3	.0040	125,800

Normal Spring Waters and those in which the Excess of Chlorine above the Normal is not more than .10 Parts per 100,000 — Continued.

Sutton, Calumet Mineral Spring.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
33596	Nov. 6, 1900, from spring,	.35	9.60	.0006	.0018	0.18	.0020	.0000	.02	3.1	.3000	–
34609	Jan. 28, 1900, from spring,	–	9.60	.0000	.0008	0.19	.0030	.0000	.00	3.1	.2200	3
33597	Nov. 6, 1900, as sold, .	.03	7.90	.0000	.0016	0.18	.0030	.0000	.06	3.3	.0050	1,400
34601	Jan. 28, 1900, as sold, .	.10	8.40	.0012	.0014	0.19	.0030	.0000	.00	3.1	.0700	6,300

Concord, Concord Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
35334	Apr. 5, 1901, from spring,	.00	2.70	.0000	.0014	0.20	.0300	.0000	.02	0.2	.0040	4
35706	May 16, 1901, from spring,	.00	2.20	.0004	.0012	0.20	.0220	.0000	.03	0.3	.0040	5
36221	July 3, 1901, from spring,	.00	2.40	.0016	.0050	0.37	.0260	.0000	.01	0.6	.0040	18

Hingham, Mount Blue Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32748	Aug. 30, 1900, from spring,	.00	4.80	.0008	.0038	0.69	.0090	.0000	.03	0.6	.0080	43
32749	Aug. 30, 1900, as sold, .	.00	4.80	.0008	.0020	0.69	.0100	.0000	.00	0.6	.0090	–

Middleborough, Nemasket Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
34331	Jan. 3, 1901, from spring,	.00	3.40	.0004	.0002	0.55	.0370	.0000	.01	0.6	.0050	–
*553	– from spring,	–	–	–	–	–	–	–	–	–	–	2
33248	Oct. 8, 1900, as sold, .	.00	4.00	.0000	.0008	0.51	.0340	.0000	.00	0.8	.0020	38,500
34332	Jan. 3, 1901, as sold, .	.00	3.60	.0006	.0014	0.54	.0350	.0000	.01	0.6	.0050	11,000

Methuen, Abbott's Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
L. 28591	Aug. 21, 1900, from spring,	.00	12.00	.0002	.0012	0.18	.0190	.0000	.01	2.2	.0005	4
33965	Dec. 7, 1900, from spring,	.00	5.30	.0004	.0012	0.22	.0110	.0000	.01	2.0	.0050	0
L. 28599	Aug. 21, 1900, as sold, .	.00	13.00	.0008	.0012	0.17	.0180	.0000	.03	2.6	.0015	*39,300
33966	Dec. 7, 1900, as sold, .	.00	5.30	.0010	.0006	0.22	.0100	.0000	.01	2.1	.0040	366

Easton, Simpson Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32999	Sept. 19, 1900, from spring,	.01	3.70	.0000	.0018	0.36	.0330	.0000	.00	0.8	.0000	25
34339	Jan. 4, 1901, from spring,	.00	3.10	.0006	.0040	0.39	.0330	.0000	.01	1.3	.0080	–
†552	– from spring,	–	–	–	–	–	–	–	–	–	–	3
33000	Sept. 19, 1900, as sold, .	.00	3.70	.0000	.0010	0.37	.0290	.0000	.00	1.3	.0000	–
34334	Jan. 3, 1901, as sold, .	.00	3.70	.0008	.0016	0.36	.0290	.0000	.01	1.3	.0040	243,500

Chelmsford, Golden Cove Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
34148	Dec. 18, 1900, from spring,	.02	2.70	.0006	.0022	0.28	.0510	.0000	.02	0.6	.0100	71

* B. coli present. † Bacterial number.

Normal Spring Waters and those in which the Excess of Chlorine above the Normal is not more than .10 Parts per 100,000 — Continued.

Millbury, Howe's Spring.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
				Free.	Albuminoid.		Nitrates.	Nitrites.				
33358	Oct. 18, 1900, from spring,	.02	4.20	.0000	.0056	0.25	.0280	.0000	.11	0.6	.0100	–
34607	Jan. 28, 1901, from spring,	.00	5.20	.0000	.0040	0.27	.0330	.0000	.05	0.8	.0200	1
34842	Feb. 21, 1901, as sold, .	.00	3.20	.0006	.0032	0.21	.0210	.0000	.05	0.6	.0040	1,035

Natick, Lang Moore Spring.

33056	Sept. 24, 1900, from spring,	.00	5.50	.0035	.0017	0.25	.0050	.0000	.01	1.3	.0040	–
33918	Dec. 3, 1900, from spring,	.00	4.50	.0002	.0048	0.25	.0050	.0000	.01	1.7	.0050	0
32990	Sept. 18, 1900, as sold, .	.00	4.60	.0000	.0010	0.26	.0050	.0000	.00	1.1	.0020	10
34749	Feb. 13, 1901, as sold, .	.00	4.40	.0008	.0016	0.27	.0070	.0000	.00	1.4	.0040	26

Dracut, Baltic Spring.

33189	Oct. 4, 1900, from spring,	.04	3.50	.0006	.0094	0.28	.0050	.0000	.02	0.8	.0040	11
34128	Dec. 18, 1900, from spring,	.00	3.20	.0010	.0060	0.26	.0030	.0000	.01	0.5	.0080	10
33190	Oct. 4, 1900, as sold, .	.02	3.90	.0000	.0028	0.26	.0080	.0000	.01	0.6	.0050	–
34129	Dec. 18, 1900, as sold, .	.00	3.80	.0008	.0032	0.26	.0040	.0000	.01	0.5	.0080	235

Amesbury, Lombard Spring.

35498	Apr. 23, 1901, from spring,	.21	9.50	.0008	.0014	0.42	.0030	.0000	.01	4.6	.0500	3

Natick, Leland Spring.

33529	Oct. 31, 1900, from spring,	.03	5.70	.0008	.0084	0.24	.0030	.0000	.00	2.0	.0020	15
33919	Dec. 3, 1900, from spring,	.01	5.20	.0006	.0038	0.24	.0050	.0000	.01	2.5	.0050	9
34624	Jan. 30, 1901, as sold, .	.00	7.00	.0000	.0018	0.27	.0040	.0001	.02	1.8	.0060	792

Mattapoisett, King Philip's Mineral Spring.

33227	Oct. 8, 1900, from spring,	.00	3.90	.0044	.0050	0.62	.0040	.0000	.01	1.0	.0020	–
34673	Feb. 5, 1901, from spring,	.00	3.50	.0000	.0024	0.70	.0060	.0000	.00	0.6	.0080	0
33236	Oct. 8, 1900, as sold, .	.01	3.30	.0000	.0006	0.60	.0000	.0000	.01	0.5	.0050	1,485
34674	Feb. 5, 1901, as sold, .	.00	3.50	.0000	.0016	0.73	.0060	.0000	.00	0.6	.0020	703

Williamstown, Sand Springs.

34465	Jan. 15, 1901, from spring,	.00	11.80	.0004	.0024	0.15	.0060	.0000	.02	8.9	.0070	18
34466	Jan. 15, 1901, as sold, .	.00	11.30	.0012	.0018	0.17	.0050	.0000	.02	8.6	.0040	649

Normal Spring Waters and those in which the Excess of Chlorine above the Normal is not more than .10 Parts per 100,000 — Continued.

Stoneham, Vishnu Mineral Spring.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32541	Aug. 17, 1900, from spring,	.05	5.10	.0000	.0018	0.42	.0380	.0000	.05	1.1	.0670	29
33932	Dec. 4, 1900, from spring,	.00	4.30	.0004	.0056	0.37	.0700	.0000	.01	1.4	.0050	1
32542	Aug. 17, 1900, as sold, .	.00	5.00	.0000	.0020	0.42	.0480	.0001	.03	1.1	.0060	3,890
33957	Dec. 5, 1900, as sold, .	.01	4.90	.0012	.0022	0.38	.0680	.0000	.01	1.4	.0060	46,600

Belmont, Belmont Natural Spring.

32640	Aug. 24, 1900, from spring,	.00	9.70	.0000	.0012	0.36	.0120	.0000	.02	4.7	.0140	432
33776	Nov. 21, 1900, from spring,	.00	9.50	.0006	.0014	0.33	.0110	.0000	.01	4.4	.0040	0
32645	Aug. 25, 1900, as sold, .	.00	9.40	.0000	.0022	0.35	.0110	.0000	.01	4.6	.0020	83,800
34706	Feb. 11, 1901, as sold, .	.00	8.00	.0000	.0010	0.33	.0170	.0000	.00	3.6	.0050	7

South Hadley, Mt. Holyoke Lithia Spring.

33454	Oct. 24, 1900, from spring,	.01	5.80	.0006	.0116	0.13	.0030	.0000	.01	2.9	.0030	–
34540	Jan. 22, 1901, from spring,	.00	5.10	.0006	.0074	0.17	.0030	.0000	.02	2.2	.0080	0
34541	Jan. 22, 1901, as sold, .	.00	5.00	.0008	.0046	0.18	.0030	.0000	.02	2.2	.0050	43

Lawrence, Valpey's Spring.

L. 28583	Aug. 20, 1900, from spring,	.00	3.60	.0004	.0014	0.25	.1190	.0001	.05	0.8	.0010	8
33962	Dec. 7, 1900, from spring,	.00	4.50	.0000	.0016	0.36	.1150	.0000	.01	1.8	.0060	116
L. 28598	Aug. 21, 1900, as sold, .	.00	11.40	.0000	.0006	0.25	.1150	.0000	.01	1.0	.0020	62,600
33974	Dec. 7, 1900, as sold, .	.00	4.80	.0006	.0016	0.37	.1100	.0000	.01	2.0	.0040	26

Norwood, Norwood Spring.

33284	Oct. 12, 1900, from spring,	.05	4.10	.0012	.0130	0.36	.0390	.0000	.03	1.0	.0040	–
34491	Jan. 16, 1901, from spring,	.00	3.50	.0012	.0046	0.44	.0260	.0000	.00	0.8	.0080	10
33285	Oct. 12, 1900, as sold, .	.01	4.10	.0002	.0014	0.37	.0290	.0000	.02	1.0	.0020	7,560

Medford, Middlesex Mountain Spring.

32458	Aug. 13, 1900, from spring,	.00	6.00	.0000	.0006	0.36	.0320	.0000	.01	3.1	.0040	14
33711	Nov. 19, 1900, from spring,	.00	6.00	.0006	.0108	0.42	.0560	.0000	.05	3.4	.0050	12
32486	Aug. 14, 1900, as sold, .	.00	6.60	.0000	.0008	0.36	.0260	.0000	.01	3.3	.0060	*18,200
33712	Nov. 19, 1900, as sold, .	.00	6.10	.0000	.0016	0.40	.0520	.0000	.03	3.4	.0040	14,700

* B. coli present.

Normal Spring Waters and those in which the Excess of Chlorine above the Normal is not more than .10 Parts per 100,000 — Concluded.

Franklin, Sunnyside Spring.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
33324	Oct. 16, 1900, from spring,	.00	4.30	.0008	.0084	0.32	.0500	.0000	.01	1.1	.0040	-
34310	Jan. 1, 1901, from spring,	.00	3.70	.0006	.0090	0.41	.1240	.0000	.01	1.4	.0060	15
33325	Oct. 16, 1900, as sold,	.03	4.80	.0026	.0018	0.30	.0480	.0000	.01	2.0	.0130	22,500
34311	Jan. 1, 1901, as sold,	.00	3.90	.0006	.0010	0.41	.1300	.0000	.01	1.3	.0050	24,000

Danvers, Sager's Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32763	Aug. 31, 1900, from spring,	.00	3.80	.0000	.0008	0.44	.0270	.0000	.00	1.0	.0060	28
34033	Dec. 11, 1900, from spring,	.00	4.00	.0016	.0026	0.44	.0330	.0001	.01	2.0	.0100	45
32778	Aug. 31, 1900, as sold,	.00	3.80	.0008	.0028	0.43	.0290	.0000	.01	1.3	.0060	-
34751	Feb. 13, 1901, as sold,	.00	3.40	.0002	.0024	0.48	.1000	.0000	.01	1.3	.0050	24,000

West Springfield, Massasoit Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
33402	Oct. 23, 1900, from spring,	.00	6.70	.0010	.0102	0.11	.0030	.0000	.04	4.4	.0100	-
34538	Jan. 22, 1901, from spring,	.00	7.90	.0010	.0078	0.17	.0110	.0000	.05	4.0	.0090	43
33403	Oct. 23, 1900, as sold,	.00	7.00	.0024	.0014	0.22	.0050	.0004	.08	4.4	.0100	76,700
34539	Jan. 22, 1901, as sold,	.00	8.00	.0000	.0028	0.18	.0120	.0000	.03	3.9	.0080	8,037

Gloucester, Magnolia Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
35477	Apr. 22, 1901, from spring,	.00	5.10	.0012	.0042	1.28	.0330	.0000	.08	1.4	.0060	27
35478	Apr. 22, 1901, as sold,	.01	5.20	.0004	.0054	1.33	.0310	.0000	.08	1.7	.0060	10,700

Weymouth, Garfield Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32753	Aug. 30, 1900, from spring,	.00	5.20	.0018	.0022	0.47	.0640	.0006	.02	1.7	.0040	17
34011	Dec. 10, 1900, from spring,	.00	5.90	.0004	.0028	0.69	.1600	.0000	.01	2.2	.0040	24
32754	Aug. 30, 1900, as sold,	.00	4.40	.0018	.0060	0.46	.0650	.0005	.02	1.7	.0060	-

Group II.

Spring Waters in which the Excess of Chlorine above the Normal is between .11 and .30 Parts per 100,000.

Lowell, Mt. Pleasant Spring.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
				Free.	Albuminoid		Nitrates.	Nitrites.				
33156	Oct. 1, 1900, from spring,	.00	5.30	.0000	.0006	0.38	.1220	.0000	.00	1.6	.0040	87
34119	Dec. 17, 1900, from spring,	.00	4.10	.0000	.0002	0.34	.1000	.0000	.01	1.4	.0070	4
33182	Oct. 3, 1900, as sold,	.00	6.00	.0002	.0008	0.39	.1210	.0000	.01	1.6	.0030	-
34120	Dec. 17, 1900, as sold,	.00	4.80	.0004	.0012	0.33	.0950	.0004	.01	1.3	.0070	216

Scituate, Beaver Dam Spring.

32747	Aug. 30, 1900, from spring,	.00	6.80	.0000	.0006	1.68	.0440	.0000	.00	1.3	.0040	18
34006	Dec. 10, 1900, from spring,	.00	8.00	.0000	.0006	1.79	.0490	.0000	.01	2.1	.0040	3
32758	Aug. 30, 1900, as sold,	.00	6.70	.0000	.0008	1.66	.0450	.0000	.01	1.3	.0040	*1,300

Quincy, Shawmut Spring.

32692	Aug. 28, 1900, from spring,	.00	6.80	.0000	.0024	0.53	.0130	.0000	.01	1.8	.0220	118
34322	Jan. 2, 1901, from spring,	.00	4.50	.0000	.0014	0.56	.1000	.0000	.02	1.8	.0050	6
32766	Aug. 31, 1900, as sold,	.00	4.00	.0004	.0008	0.54	.0400	.0001	.01	0.5	.0040	-
34323	Jan. 2, 1901, as sold,	.00	4.70	.0002	.0014	0.54	.2180	.0000	.02	2.0	.0060	-

Stoneham, Middlesex Fells Spring.

32544	Aug. 17, 1900, from spring,	.00	5.40	.0006	.0022	0.44	.0090	.0000	.03	2.3	.0070	129
34605	Jan. 29, 1901, from spring,	.00	5.30	.0000	.0006	0.48	.0060	.0000	.00	2.0	.0060	4
32545	Aug. 17, 1900, as sold,	.00	5.40	.0000	.0006	0.44	.0050	.0000	.03	2.3	.0030	1,058
34606	Jan. 29, 1901, as sold,	.00	4.90	.0000	.0010	0.48	.0070	.0000	.00	2.1	.0060	84

Woburn, Silver Seal Spring.

33084	Sept. 25, 1900, from spring,	.00	6.10	.0000	.0008	0.41	.0850	.0000	.01	2.3	.0050	74
33928	Dec. 4, 1900, from spring,	.00	7.00	.0000	.0016	0.60	.2930	.0000	.00	2.7	.0080	42
33085	Sept. 25, 1900, as sold,	.00	6.00	.0008	.0012	0.42	.0600	.0001	.01	2.1	.0050	-
33933	Dec. 4, 1900, as sold,	.00	7.00	.0000	.0008	0.58	.3100	.0000	.00	2.6	.0040	3,600

Lynn, Electric Spring.

33584	Nov. 5, 1900, from spring,	.00	5.40	.0006	.0016	0.78	.0990	.0000	.01	1.4	.0100	-
34219	Dec. 22, 1900, as sold,	.00	6.40	.0012	.0016	0.85	.2000	.0000	.01	1.7	.0150	-

* B. coli present.

Spring Waters in which the Excess of Chlorine above the Normal is between .11 and .30 Parts per 100,000 — Continued.

Arlington, Robbins Spring.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32641	Aug. 24, 1900, from spring,	.00	6.00	.0000	.0004	0.47	.0900	.0000	.01	2.3	.0050	11
33753	Nov. 21, 1900, from spring,	.00	6.70	.0002	.0030	0.59	.1200	.0000	.02	2.7	.0080	93
*248	– from spring,	–	–	–	–	–	–	–	–	–	–	51
33754	Nov. 21, 1900, as sold, .	.05	6.90	.0004	.0184	0.51	.0820	.0002	.13	2.5	.0080	29

Stoneham, Beach Hill Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
33929	Dec. 4, 1900, from spring,	.01	5.90	.0006	.0014	0.49	.1050	.0000	.01	2.2	.0100	10
34608	Jan. 29, 1901, from spring,	.00	5.60	.0006	.0060	0.55	.1000	.0000	.02	1.4	.0030	33

Gloucester, Niagara Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
35479	Apr. 22, 1901, from spring,	.00	5.70	.0004	.0048	1.11	.1950	.0000	.02	2.0	.0040	100

Needham, Bird's Hill Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32701	Aug. 28, 1900, from spring,	.00	4.60	.0000	.0010	0.49	.0810	.0000	.00	1.1	.0040	6
34489	Jan. 16, 1901, from spring,	.00	6.40	.0010	.0026	0.62	.3100	.0000	.01	2.5	.0040	35
32702	Aug. 28, 1900, as sold, .	.00	4.60	.0000	.0018	0.50	.0820	.0000	.01	1.3	.0070	–
34490	Jan. 16, 1901, as sold, .	.00	6.50	.0006	.0020	0.63	.4050	.0000	.01	2.0	.0050	190

Wilbraham, Wilbraham Mountain Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
33435	Oct. 24, 1900, from spring,	.00	8.60	.0000	.0068	0.33	.0500	.0000	.01	4.9	.0060	–
34590	Jan. 25, 1901, from spring,	.00	8.30	.0002	.0004	0.33	.0940	.0000	.02	4.3	.0030	2
33515	Oct. 30, 1900, as sold, .	.02	9.40	.0010	.0064	0.36	.0570	.0006	.08	4.6	.0100	8,000
35721	May 17, 1901, as sold, .	.00	11.20	.0010	.0014	0.33	.1040	.0000	.02	5.6	.0040	–

Winchester, Fairmont Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32764	Aug. 31, 1900, from spring,	.00	8.50	.0000	.0016	0.58	.1550	.0000	.01	3.5	.0040	44
33927	Dec. 4, 1900, from spring,	.00	8.70	.0000	.0038	0.37	.3100	.0000	.01	3.3	.0080	0
32783	Aug. 31, 1900, as sold, .	.00	7.70	.0010	.0024	0.46	.1250	.0001	.01	2.9	.0030	–
33934	Dec. 4, 1900, as sold, .	.01	8.60	.0028	.0022	0.39	.3150	.0001	.01	3.3	.0050	6,100

Revere, Columbia Lithia Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
L. 28574	Aug. 17, 1900, from spring,	.00	9.30	.0000	.0014	0.70	.1160	.0000	.02	2.5	.0005	13,400
33726	Nov. 20, 1900, from spring,	.00	9.20	.0000	.0020	0.86	.1280	.0001	.00	3.1	.0050	187
L. 28576	Aug. 17, 1900, as sold, .	.00	17.20	.0002	.0008	0.71	.1630	.0000	.00	2.3	.0005	54
33727	Nov. 20, 1900, as sold, .	.00	9.30	.0000	.0004	0.86	.1280	.0000	.00	3.1	.0040	90,200

* Bacterial number.

Spring Waters in which the Excess of Chlorine above the Normal is between .11 and .30 Parts per 100,000 — Concluded.

New Bedford, Howland Spring.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
33233	Oct. 8, 1900, from spring,	.10	7.70	.0000	.0032	0.85	.1900	.0001	0.06	1.7	.1040	-
34680	Feb. 5, 1901, from spring,	.00	5.60	.0004	.0048	0.66	.0560	.0000	0.00	1.7	.0060	6
33247	Oct. 8, 1900, as sold,	.03	9.10	.0006	.0086	0.86	.2230	.0001	1.20	1.7	.0050	43,800

Brockton, Brockton Mineral Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
L. 28725	Sept. 12, 1900, from spring,	.00	7.50	.0016	.0024	0.64	.0901	.0002	0.02	1.1	.0055	*132
34051	Dec. 12, 1900, from spring,	.01	4.50	.0004	.0048	0.61	.0330	.0000	0.01	1.6	.0040	183
L. 28726	Sept. 12, 1900, as sold,	.00	7.70	.0016	.0024	0.64	.1009	.0001	0.04	1.1	.0055	292
34052	Dec. 12, 1900, as sold,	.01	5.00	.0002	.0032	0.60	.0300	.0000	0.01	1.4	.0050	*282

Methuen, Crystal Mineral Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
L. 28592	Aug. 21, 1900, from spring,	.00	15.40	.0004	.0014	0.46	.1850	.0000	0.04	2.1	.0015	1,100
33969	Dec. 7, 1900, from spring,	.00	8.30	.0000	.0012	0.51	.3350	.0000	0.01	3.3	.0040	4
L. 28594	Aug. 21, 1900, as sold,	.00	14.20	.0018	.0030	0.47	.2820	.0000	0.03	2.1	.0020	1,100
33970	Dec. 7, 1900, as sold,	.00	8.50	.0000	.0012	0.50	.3700	.0000	0.01	3.1	.0030	14

Chelmsford, Robin's Hill Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
33188	Oct. 4, 1900, from spring,	.01	9.20	.0004	.0024	0.31	.0490	.0001	0.04	5.1	.0050	-
34149	Dec. 18, 1900, from spring,	.00	7.30	.0006	.0040	0.47	.0990	.0000	0.02	3.9	.0080	9
33183	Oct. 3, 1900, as sold,	.05	9.70	.0004	.0032	0.32	.0510	.0000	0.08	5.3	.0080	93
34150	Dec. 18, 1900, as sold,	.00	7.50	.0006	.0022	0.45	.1030	.0000	0.01	3.9	.0080	154,800

Lawrence, Bodwell Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
L. 28590	Aug. 21, 1900, from spring,	.05	15.40	.0010	.0064	0.41	.1630	.0000	0.28	1.7	.0045	48
33997	Dec. 10, 1900, from spring,	.00	7.10	.0004	.0038	0.52	.1450	.0000	0.01	2.1	.0040	24
L. 28595	Aug. 21, 1900, as sold,	.00	9.90	.0004	.0006	0.41	.1700	.0000	0.04	1.9	.0005	4,300
33998	Dec. 10, 1900, as sold,	.01	6.90	.0018	.0024	0.54	.1550	.0000	0.01	2.1	.0030	19,300

Tewksbury, Clark's Ledge Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
33154	Oct. 1, 1900, from spring,	.01	6.40	.0002	.0012	0.51	.1730	.0001	0.00	2.6	.0060	63
34115	Dec. 17, 1900, from spring,	.00	7.40	.0000	.0018	0.50	.3350	.0000	0.01	2.9	.0100	14
33185	Oct. 3, 1900, as sold,	.00	7.60	.0000	.0014	0.56	.1870	.0000	0.01	2.3	.0060	-
34116	Dec. 17, 1900, as sold,	.00	6.00	.0004	.0036	0.51	.3600	.0000	0.02	2.7	.0100	33

* B. coli present.

Group III.

Spring Waters in which the Excess of Chlorine above the Normal is more than .30 Parts per 100,000

Abington, Highland Spring.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
L. 28727	Sept. 12, 1900, from spring,	.00	8.70	.0006	.0022	0.72	.1365	.0000	.01	1.4	.0090	159
34059	Dec. 12, 1900, from spring,	.00	5.80	.0000	.0020	0.85	.2060	.0000	.01	2.0	.0060	14
L. 28728	Sept. 12, 1900, as sold,	.00	9.70	.0006	.0020	0.72	.1365	.0000	.01	1.4	.0075	6,200
34060	Dec. 12, 1900, as sold,	.01	5.80	.0026	.0034	0.88	.1730	.0003	.01	2.1	.0060	5,300

Methuen, Burnham Spring.

L. 28584	Aug. 20, 1900, from spring,	.00	7.10	.0000	.0008	1.14	.1890	.0000	.02	2.1	.0005	8
33967	Dec. 7, 1900, from spring,	.00	9.30	.0000	.0014	1.24	.1550	.0000	.02	4.0	.0040	5
L. 28596	Aug. 21, 1900, as sold,	.00	11.50	.0004	.0008	1.07	.1850	.0000	.02	2.1	.0005	22,200
33968	Dec. 7, 1900, as sold,	.00	9.00	.0000	.0010	1.24	.1350	.0000	.02	4.0	.0030	6,100

Lawrence, Knowles' Diamond Spring.

L. 28585	Aug. 20, 1900, from spring,	.00	7.90	.0002	.0010	0.73	.2850	.0000	.02	1.8	.0010	17
33959	Dec. 7, 1900, from spring,	.00	8.50	.0006	.0018	0.72	.2350	.0000	.01	3.6	.0060	1
L. 28597	Aug. 21, 1900, as sold,	.00	15.80	.0002	.0014	0.71	.2900	.0000	.02	1.9	.0015	6,600
33972	Dec. 7, 1900, as sold,	.02	8.30	.0000	.0012	0.72	.2600	.0000	.01	3.4	.0040	141

Whitman, Goulding's Spring.

L. 28729	Sept. 12, 1900, from spring,	.00	6.20	.0002	.0018	0.84	.2860	.0000	.01	0.70	.0185	84
34061	Dec. 12, 1900, from spring,	.00	7.50	.0004	.0048	0.99	.3400	.0000	.01	1.70	.0070	0
L. 28730	Sept. 13, 1900, as sold,	.00	6.60	.0002	.0002	0.85	.2910	.0004	.01	0.70	.0120	3,500
34062	Dec. 12, 1900, as sold,	.00	7.70	.0020	.0016	1.00	.3200	.0005	.01	2.10	.0070	300

Brockton, Granite Rock Spring.

33003	Sept. 19, 1900, from spring,	.00	6.80	.0000	.0020	0.79	.2170	.0000	.00	2.2	.0020	37
34055	Dec. 12, 1900, from spring,	.00	7.00	.0008	.0044	0.88	.2480	.0000	.01	2.1	.0040	*16
L. 28724	Sept. 12, 1900, as sold,	.00	10.70	.0000	.0006	0.75	.2990	.0000	.03	0.9	.0060	2,500
34056	Dec. 12, 1900, as sold,	.00	7.40	.0006	.0028	0.88	.1950	.0000	.01	2.5	.0050	6

Wakefield, Montrose Spring.

32765	Aug. 31, 1900, from spring,	.00	9.50	.0000	.0020	0.83	.2450	.0000	.01	3.1	.0020	12
34018	Dec. 11, 1900, from spring,	.00	8.50	.0000	.0020	0.76	.2950	.0000	.01	3.6	.0040	5
32777	Aug. 31, 1900, as sold,	.00	9.30	.0014	.0058	0.84	.2750	.0000	.01	3.3	.0030	900
34034	Dec. 11, 1900, as sold,	.00	9.00	.0010	.0034	0.75	.2900	.0000	.01	3.6	.0060	75

* B. coli present.

Spring Waters in which the Excess of Chlorine above the Normal is more than .30 Parts per 100,000 — Continued.

Quincy, Puritan Spring.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
34602	Jan. 29, 1901, from spring,	.00	7.00	.0010	.0018	0.96	.1930	.0000	.01	1.7	.0070	4
34603	Jan. 29, 1901, as sold,	.00	6.80	.0032	.0022	0.95	.2000	.0000	.01	1.4	.0070	160

Fitchburg, Pearl Hill Mineral Spring.

33379	Oct. 22, 1900, from spring,	.00	4.70	.0004	.0084	0.57	.1030	.0000	.00	1.4	.0100	–
34303	Dec. 31, 1900, from spring,	.00	3.80	.0014	.0046	0.43	.0300	.0000	.01	1.1	.0060	8
33538	Nov. 1, 1900, as sold,	.01	5.10	.0068	.0050	0.58	.0000	.0000	.01	1.4	.0020	10,600

Chelsea, Mt. Washington Spring.

32485	Aug. 14, 1900, from spring,	.00	10.90	.0000	.0006	0.87	.0550	.0000	.01	4.6	.0040	19
33730	Nov. 20, 1900, from spring,	.01	14.00	.0008	.0014	0.87	.0640	.0000	.01	5.7	.0080	123
32522	Aug. 15, 1900, as sold,	.00	11.40	.0000	.0010	0.89	.0530	.0000	.03	5.1	.0020	567
33770	Nov. 22, 1900, as sold,	.00	18.60	.0018	.0022	0.90	.0540	.0001	.01	6.0	.0120	706

Scituate, Egypt Spring.

32746	Aug. 30, 1900, from spring,	.00	17.20	.0000	.0008	3.97	.2600	.0000	.05	3.8	.0050	6,000
34007	Dec. 10, 1900, from spring,	.00	13.40	.0000	.0006	3.78	.3180	.0000	.01	4.9	.0040	5
32843	Aug. 30, 1900, as sold,	.00	17.90	.0004	.0028	3.96	.2650	.0001	.02	4.0	.0030	*26,300

Danvers, Lakoo Indian Crystal Spring.

32761	Aug. 31, 1900, from spring,	.00	5.00	.0000	.0006	0.67	.1210	.0000	.02	1.3	.0050	7
34032	Dec. 11, 1900, from spring,	.00	10.50	.0020	.0032	0.94	.7200	.0000	.01	3.4	.0050	4
32762	Aug. 31, 1900, as sold,	.00	4.90	.0010	.0014	0.66	.1100	.0001	.01	1.1	.0040	–
34240	Dec. 27, 1900, as sold,	.00	9.20	.0006	.0012	0.96	.5600	.0000	.01	2.9	.0050	23

Westford, Nashoba Spring.

33178	Oct. 3, 1900, from spring,	.00	8.40	.0002	.0042	0.59	.0440	.0000	.01	3.8	.0030	68
34151	Dec. 18, 1900, from spring,	.00	7.00	.0012	.0082	0.72	.1900	.0000	.02	2.2	.0040	15
33184	Oct. 3, 1900, as sold,	.00	8.70	.0000	.0012	0.58	.0510	.0000	.03	3.5	.0050	–
34152	Dec. 18, 1900, as sold,	.00	6.20	.0006	.0024	0.63	.1550	.0000	.02	2.2	.0050	8,900

Springfield, Ingersoll Grove Spring.

32385	Aug. 6, 1900, from spring,	.00	11.20	.0000	.0004	0.88	.5600	.0000	.03	3.5	.0030	–
33401	Oct. 23, 1900, from spring,	.00	10.80	.0000	.0018	0.82	.4660	.0000	.00	4.0	.0080	–
34536	Jan. 22, 1901, from spring,	.00	9.50	.0000	.0016	0.88	.4400	.0000	.00	3.1	.0070	1
†516	– as sold,	–	–	–	–	–	–	–	–	–	–	193

* B. coli present. † Bacterial number.

Spring Waters in which the Excess of Chlorine above the Normal is more than .30 Parts per 100,000 — Continued.

Weymouth, Avonia Spring.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32751	Aug. 30, 1900, from spring,	.00	8.40	.0010	.0044	0.98	.2000	.0000	.01	2.3	.0100	11
34009	Dec. 10, 1900, from spring,	.00	8.30	.0008	.0032	0.94	.2350	.0000	.01	2.7	.0050	16
32752	Aug. 30, 1900, as sold, .	.00	7.80	.0006	.0016	0.98	.1970	.0000	.01	2.3	.0030	–
34010	Dec. 10, 1900, as sold, .	.00	8.10	.0006	.0034	0.95	.2580	.0000	.01	2.7	.0040	6,500

Duxbury, Myles Standish Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
33311	Oct. 15, 1900, from spring,	.01	10.70	.0004	.0024	2.94	.0930	.0000	.01	3.1	.0030	–
33984	Dec. 10, 1900, from spring,	.00	10.80	.0004	.0028	3.17	.1190	.0000	.02	3.0	.0050	2
33301	Oct. 15, 1900, as sold, .	.03	10.50	.0026	.0018	2.90	.0940	.0002	.02	3.3	.0100	*53,300
33985	Dec. 10, 1900, as sold, .	.06	11.00	.0058	.0024	3.16	.1170	.0006	.02	3.1	.0400	510

Malden, Linden Mineral Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32459	Aug. 13, 1900, from spring,	.00	8.90	.0006	.0026	0.94	.2200	.0000	.03	3.0	.0080	218
33728	Nov. 20, 1900, from spring,	.00	10.50	.0002	.0016	1.11	.3200	.0000	.01	3.4	.0120	53
L. 28575	Aug. 17, 1900, as sold, .	.00	9.70	.0000	.0014	0.55	.2820	.0000	.06	1.6	.0020	166

Belmont, Trapelo Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32638	Aug. 24, 1900, from spring,	.00	11.50	.0000	.0016	0.58	.3350	.0000	.02	4.4	.0030	602
33777	Nov. 21, 1900, from spring,	.00	11.80	.0004	.0034	0.63	.3750	.0000	.01	4.0	.0030	202
32639	Aug. 24, 1900, as sold, .	.00	11.80	.0000	.0014	0.59	.3600	.0000	.02	4.4	.0130	–

Milton, Milton Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32691	Aug. 28, 1900, from spring,	.00	12.40	.0000	.0016	1.24	.3750	.0000	.00	3.4	.0070	175
34320	Jan. 2, 1901, from spring,	.00	11.00	.0004	.0016	1.08	.7300	.0000	.01	3.5	.0160	326
32750	Aug. 30, 1900, as sold, .	.00	13.40	.0000	.0014	1.24	.5500	.0001	.02	3.3	.0080	–
34321	Jan. 2, 1901, as sold, .	.00	11.10	.0004	.0018	1.08	.7000	.0000	.01	3.5	.0100	28

Lawrence, Stevens Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
L. 28582	Aug. 20, 1900, from spring,	.00	10.90	.0006	.0004	0.71	.3250	.0000	.04	1.9	.0005	56
33961	Dec. 7, 1900, from spring,	.00	10.50	.0020	.0018	0.82	.3000	.0000	.02	4.4	.0040	31
L. 28601	Aug. 21, 1900, as sold, .	.00	13.10	.0004	.0008	0.71	.3300	.0000	.03	2.2	.0035	6,800
33973	Dec. 7, 1900, as sold, .	.00	10.90	.0016	.0020	0.83	.3350	.0001	.01	4.3	.0050	*1,015

Natick, Pequot Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32975	Sept. 18, 1900, from spring,	.00	8.40	.0000	.0056	0.77	.2600	.0000	.00	2.2	.0050	–
33908	Dec. 3, 1900, from spring,	.00	7.70	.0014	.0096	0.76	.2800	.0000	.01	2.5	.0040	31
32986	Sept. 18, 1900, as sold, .	.02	8.30	.0014	.0014	0.76	.2500	.0010	.00	3.0	.0020	96
33920	Dec. 3, 1900, as sold, .	.01	8.10	.0028	.0034	0.66	.2300	.0000	.02	2.6	.0060	–

* B. coli present.

Spring Waters in which the Excess of Chlorine above the Normal is more than .30 Parts per 100,000 — Continued.

Belmont, Belmont Crystal.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.*	Bacteria per Cubic Centimeter.
32670	Aug. 27, 1900, from spring,	.01	11.60	.0000	.0022	0.72	.4300	.0000	.02	4.2	.0050	1 00
33774	Nov. 21, 1900, from spring,	.00	13.10	.0008	.0024	0.80	.5150	.0000	.02	4.4	.0100	39
32671	Aug. 27, 1900, as sold,	.00	11.70	.0000	.0020	0.70	.3500	.0000	.02	4.0	.0060	*483,000
33752	Nov. 21, 1900, as sold,	.00	11.40	.0000	.0032	0.74	.4500	.0001	.01	4.3	.0060	120,200

Springfield, Hygeia Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.*	Bacteria per Cubic Centimeter.
33400	Oct. 23, 1900, from spring,	.00	20.20	.0006	.0018	0.98	.1310	.0000	.01	3.3	.0050	–
34537	Jan. 22, 1901, from spring,	.00	19.20	.0004	.0018	1.08	.0580	.0000	.00	9.9	.0150	3

Haverhill, Smiley's Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.*	Bacteria per Cubic Centimeter.
34254	Dec. 28, 1900, from spring,	.00	14.50	.0022	.0020	0.85	.0030	.0000	.01	7.4	.0060	0
33113	Sept 26, 1900, as sold,	.00	14.50	.0028	.0044	0.83	.0030	.0000	.02	7.3	.0050	2
34255	Dec. 28, 1900, as sold,	.00	14.40	.0022	.0014	0.86	.0030	.0000	.01	7.4	.0060	[430

Lexington, Katahdin Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.*	Bacteria per Cubic Centimeter.
32658	Aug. 27, 1900, from spring,	.00	8.30	.0014	.0132	0.76	.2150	.0000	.04	2.6	.0040	23
33748	Nov. 21, 1900, from spring,	.00	7.50	.0000	.0072	0.74	.2280	.0001	.01	3.1	.0080	1
32742	Aug. 24, 1900, as sold,	.00	7.90	.0000	.0016	0.74	.2470	.0001	.01	2.6	.0030	–
33749	Nov. 21, 1900, as sold,	.00	7.90	.0000	.0028	0.74	.2400	.0000	.01	3.1	.0050	308,300

Lynn, Lovers' Leap Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.*	Bacteria per Cubic Centimeter.
33583	Nov. 5, 1900, from spring,	.02	12.80	.0006	.0020	1.36	.6000	.0000	.01	3.5	.0060	–
34220	Dec. 22, 1900, as sold,	.00	7.30	.0008	.0032	1.08	.1500	.0000	.02	2.5	.0100	–

Lowell, Leland Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.*	Bacteria per Cubic Centimeter.
33177	Oct. 3, 1900, from spring,	.00	18.50	.0000	.0014	1.23	.6100	.0000	.00	6.6	.0060	19
34118	Dec. 17, 1900, from spring,	.00	19.20	.0000	.0020	1.65	.8500	.0000	.01	6.9	.0070	13
34599	Jan. 28, 1901, as sold,	.02	14.50	.0004	.0020	1.24	.7300	.0002	.07	4.7	.0050	155

Whitman, Whitman Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.*	Bacteria per Cubic Centimeter.
L. 28723	Sept. 12, 1900, from spring,	.00	14.40	.0000	.0018	1.26	.7250	.0000	.00	0.7	.0065	408
34063	Dec. 12, 1900, from spring,	.00	10.50	.0006	.0026	1.22	.6800	.0002	.01	3.0	.0050	*928
L. 28732	Sept. 13, 1900, as sold,	.00	9.70	.0036	.0032	1.27	.6152	.0008	.00	0.7	.0085	416

* B. coli present.

Spring Waters in which the Excess of Chlorine above the Normal is more than .30 Parts per 100,000 — Continued.

Lynnfield, Deep Rock Spring.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
33585	Nov. 5, 1900, from spring,	.01	10.90	.0038	.0024	0.77	.0470	.0001	.02	9.1	.0130	–
34016	Dec. 11, 1900, from spring,	.01	9.30	.0026	.0022	0.47	.0730	.0001	.02	9.4	.0280	29
33586	Nov. 5, 1900, as sold,	.01	11.00	.0046	.0034	0.78	.0510	.0001	.01	9.3	.0100	11,800
34780	Feb. 15, 1901, as sold,	.00	11.40	.0016	.0014	0.97	.0750	.0003	.01	10.2	.0040	3,500

Lowell, Highland Spring.

33155	Oct. 1, 1900, from spring,	.00	9.10	.0000	.0036	1.11	.2180	.0003	.00	3.8	.0070	173
34117	Dec. 17, 1900, from spring,	.02	11.50	.0006	.0080	2.27	.1350	.0000	.01	3.5	.0080	96
33186	Oct. 3, 1900, as sold,	.00	10.80	.0006	.0030	1.12	.2200	.0003	.04	3.8	.0050	–
34600	Jan. 28, 1901, as sold,	.00	7.50	.0022	.0020	1.21	.1480	.0000	.05	2.9	.0060	175

Natick, Maher's Spring.

34750	Feb. 13, 1901, from spring,	.00	6.50	.0004	.0028	0.80	.1250	.0000	.01	2.5	.0040	8
34634	Jan. 31, 1901, as sold,	.00	7.50	.0006	.0034	0.88	.1250	.0000	.02	2.3	.0040	424
35862	June 5, 1901, as sold,	.00	7.90	.0000	.0066	0.72	.1050	.0001	.02	3.1	.0100	–

Lawrence, Hygiene Spring.

L. 28593	Aug. 21, 1900, from spring,	.00	30.30	.0004	.0006	1.82	.9050	.0000	.02	6.3	.0015	23
33960	Dec. 7, 1900, from spring,	.00	19.90	.0002	.0034	1.94	.6750	.0000	.01	7.9	.0050	18
L. 28600	Aug. 21, 1900, as sold,	.00	22.60	.0004	.0008	1.81	.8350	.0000	.02	6.4	.0040	22,200
33971	Dec. 7, 1900, as sold,	.00	20.30	.0002	.0030	1.97	.6300	.0000	.01	7.1	.0060	79

Stoneham, Chapman Crystal Mineral Spring.

32539	Aug. 17, 1900, from spring,	.00	12.50	.0006	.0030	1.13	.5100	.0001	.04	3.5	.0090	48
33930	Dec. 4, 1900, from spring,	.00	10.00	.0008	.0040	1.03	.4500	.0000	.01	3.1	.0080	566
32540	Aug. 17, 1900, as sold,	.00	12.20	.0000	.0012	1.12	.5100	.0000	.05	3.5	.0090	1,654
33931	Dec. 4, 1900, as sold,	.00	9.90	.0010	.0046	1.01	.4200	.0000	.02	3.0	.0080	10,300

Boston, Undine Spring.

33526	Oct. 31, 1900, from spring,	.00	19.50	.0010	.0114	2.42	.7700	.0000	.02	5.4	.0110	65
34488	Jan. 16, 1901, from spring,	.00	18.30	.0004	.0028	1.68	.8000	.0000	.03	5.1	.0040	27
33599	Nov. 7, 1900, as sold,	.00	18.70	.0008	.0040	2.39	.8900	.0000	.01	5.4	.0050	272
34746	Feb. 12, 1901, as sold,	.00	13.10	.0000	.0018	1.68	.6400	.0000	.01	4.9	.0040	703

Spring Waters in which the Excess of Chlorine above the Normal is more than .30 Parts per 100,000 — Continued.

Brockton, Brockton Crystal Spring.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
33001	Sept. 19, 1900, from spring,	.02	13.40	.0010	.0042	1.52	0.4000	.0001	.07	4.3	.0030	*2,650
34054	Dec. 12, 1900, from spring,	.00	11.50	.0006	.0106	1.38	0.5500	.0000	.02	3.4	.0040	4
33002	Sept. 19, 1900, as sold, .	.10	14.30	.0010	.0068	1.69	0.3470	.0002	.16	5.4	.0030	-
34053	Dec. 12, 1900, as sold, .	.00	11.70	.0022	.0056	1.38	0.6200	.0000	.02	3.4	.0040	17,300

Swampscott, Bassett's Spring.

33130	Sept. 29, 1900, from spring,	.01	29.50	.0002	.0016	3.90	1.0000	.0001	.01	11.8	.0050	-
33131	Sept. 29, 1900, as sold, .	.01	0.30	.0142	.0006	0.01	0.0030	.0000	.00	0.0	.0050	-

Holbrook, Mingo Spring.

33004	Sept. 19, 1900, from spring,	.01	14.40	.0006	.0026	2.02	0.7550	.0001	.00	3.1	.0030	153
34319	Jan. 2, 1901, from spring,	.00	12.50	.0008	.0122	2.02	0.7500	.0000	.02	3.4	.0050	112
33037	Sept. 21, 1900, as sold, .	.00	14.30	.0010	.0066	2.04	0.7400	.0004	.06	2.9	.0160	-

Everett, Everett Crystal Spring.

32483	Aug. 14, 1900, from spring,	.00	27.70	.0000	.0020	2.54	1.4900	.0001	.03	8.0	.0070	695
33731	Nov. 20, 1900, from spring,	.00	29.50	.0002	.0024	2.52	1.7200	.0000	.01	7.7	.0080	32
32523	Aug. 15, 1900, as sold, .	.00	27.70	.0004	.0026	2.54	1.4200	.0000	.04	7.4	.0030	11,100
33781	Nov. 22, 1900, as sold, .	.00	27.30	.0008	.0046	2.52	1.7500	.0001	.03	8.6	.0220	14,500

Framingham, Hamilton Mineral Spring.

33057	Sept. 24, 1900, from spring,	.00	8.20	.0002	.0094	0.28	0.0050	.0000	.01	3.9	.0080	62
33916	Dec. 3, 1900, from spring,	.57	15.10	.0150	.0250	2.33	0.4700	.0030	.87	3.9	.0050	253
34625	Jan. 30, 1901, as sold, .	.00	7.20	.0002	.0014	0.29	0.0070	.0000	.00	3.6	.0040	660

Lexington, Lexington Spring.

32659	Aug. 27, 1900, from spring,	.00	10.70	.0020	.0078	1.70	0.3800	.0000	.02	3.3	.0040	424
33756	Nov. 22, 1900, from spring,	.02	13.00	.0008	.0038	1.54	0.6600	.0007	.01	4.4	.0060	3,192
32703	Aug. 24, 1900, as sold, .	.00	10.80	.0006	.0020	1.14	0.3500	.0001	.01	3.0	.0030	3,100
33757	Nov. 22, 1900, as sold, .	.02	15.00	.0006	.0044	1.65	0.8000	.0009	.04	5.3	.0130	111,300

Stoneham, Bear Hill Mineral Spring.

32543	Aug. 17, 1900, from spring,	.02	26.80	.0000	.0052	1.56	1.4400	.0002	.08	7.4	.0780	*838
34691	Feb. 8, 1901, from spring,	.00	17.20	.0008	.0036	1.09	1.8000	.0003	.02	6.0	.0080	-

* B. coli present.

Spring Waters in which the Excess of Chlorine above the Normal is more than .30 Parts per 100,000 — Concluded.

Everett, Belmont Hill Spring.

[Parts per 100,000.]

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
				Free.	Albuminoid.		Nitrates.	Nitrites.				
32482	Aug. 14, 1900, from spring,	.00	29.10	.0000	.0020	2.59	1.3370	.0004	.02	7.3	.0050	277
33714	Nov. 19, 1900, from spring,	.00	34.00	.0006	.0030	2.76	1.4500	.0000	.02	7.3	.0030	63
32533	Aug. 17, 1900, as sold, .	.00	29.80	.0006	.0024	2.55	1.4300	.0010	.04	7.3	.0040	5,750
34740	Feb. 13, 1901, as sold, .	.00	20.00	.0004	.0018	2.05	1.5000	.0001	.01	9.4	.0040	3,000

Lexington, Larchmont Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
32622	Aug. 23, 1900, from spring,	.00	13.00	.0044	.0028	0.93	0.4750	.0011	.02	5.1	.0020	*84
33750	Nov. 21, 1900, from spring,	.00	16.00	.0112	.0052	1.04	0.9100	.0021	.01	5.4	.0050	3,316
32623	Aug. 23, 1900, as sold, .	.00	14.80	.0046	.0042	0.93	0.4900	.0016	.02	5.6	.0090	88,800
33751	Nov. 21, 1900, as sold, .	.02	6.70	.0048	.0048	0.47	0.1550	.0007	.02	3.3	.0060	612

Swampscott, Moose Hill Spring.

Number.	Date and Place of Collection.	Color.	Residue on Evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Bacteria per Cubic Centimeter.
33128	Sept. 29, 1900, from spring,	.00	27.40	.0820	.0052	3.45	1.0130	.0016	.02	9.4	.0030	-
33326	Oct. 17, 1900, from spring,	.01	26.50	.0336	.0092	3.20	1.0550	.0011	.07	7.6	.0040	-
33129	Sept. 29, 1900, as sold, .	.01	22.50	.0216	.0036	2.93	0.7300	.0005	.02	7.3	.0040	-

Descriptions of the Springs and their Surroundings.

Group I.

Lowell, El Azhar Spring (formerly Sheep-rock Spring). — Situated north-east of Varnum Avenue, in the north-west corner of the city. The territory in the vicinity of the spring consists of uninhabited woodland. Water is obtained from a tubular well 80 feet deep, driven in rock, and is pumped into a soapstone tank located in the bottling house from which the bottles are filled. The bottles are subjected to a sterilizing process by exposing them to a high temperature. Sold in Lowell.

Andover, Ballardvale Lithia Spring. — Situated in the southern part of the town, near Wilmington line, about 200 feet west of the road from Wilmington to Andover. The water-shed is uninhabited and consists chiefly of woodland. The owners of the spring control a considerable tract of land immediately adjoining the spring.

* B. coli present.

Water is collected in a stone reservoir approximately 10 feet in diameter and 17 feet deep, covered by a stone building, from which it is pumped through an iron pipe to wooden tanks in which it is carried to the bottling house at Lowell Junction. The water is sold in bottles at various places.

Gloucester, Ravenwood Spring. — Situated in western part of Gloucester near Western Avenue, about one mile west of Bond Street. Water-shed uninhabited woodland. Water is collected in a cement pipe 18 inches in diameter and 3 feet long resting on ledge. Bottles are filled from faucet or by dipping water out of the pipe with a dipper. Sold in Gloucester.

Fall River, Banquet Spring. — This spring was not visited, but was said to be situated in the north-easterly part of the city, in the midst of a large tract of uninhabited woodland. The water is distributed in bottles in New Bedford.

Milton, Farrington Silver Spring. — Situated about 600 feet east of Randolph Avenue and 300 feet north-west of the parkway, on the western slope of Chicatawbut Hill. The greater part of the water-shed is within the park reservation and is uninhabited. Water is collected in two reservoirs 60 feet apart, each of which is about 4 feet in diameter and 10 feet deep. The upper spring is used for the greater part of the year when the yield is sufficient. A small reservoir, used for the collection of surface water for filling street watering carts, is situated about 10 feet from the lower spring. This reservoir is at a higher elevation than the lower spring, and when full some of the water may filter into the spring. The springs are covered with wooden covers but surface water may enter them. The bottles are filled at the springs by means of a pump. Sold in Milton and Boston.

Braintree, Monatiquot Spring. — Situated in the westerly part of the town, about a mile from the South Braintree station. The territory in the vicinity of the spring consists of uninhabited woodland. Water is collected in a cemented reservoir 3 feet square and 6 feet deep, provided with a wooden cover, and is distributed in bottles which are filled with the water by means of a dipper as it overflows from the spring. Sold in Boston and other places in Massachusetts.

Mendon, Miscoe Spring. — Situated on the southerly slope of Miscoe Hill in Mendon. The slope of the hill above the spring is

thickly wooded, with the exception of a pasture near the top of the hill about half a mile from the spring. Water is collected in a reservoir of glazed tile pipe 36 inches in diameter and about 5 feet deep, provided with an iron cover, and flows by gravity through a block-tin pipe 50 feet in length to a bottling house, where the bottles in which the water is sold are filled. Sold in Milford and Boston.

North Brookfield, Quabaug Spring. — Situated in a small valley about 800 feet south of Bates Street. The water-shed is uninhabited except that there are two houses and a barn situated at a considerable distance from the spring which may drain towards it. Water is collected in a stone reservoir 10 feet square and 8 feet deep, situated in a bottling house. Water is pumped from the spring into a small wooden tank from which the bottles in which the water is distributed are filled. Sold in Worcester and Springfield.

Framingham, Nobscot Mountain Spring. — Situated 50 feet southwest of Spring Street at base of Nobscot Mountain, in northerly part of town. The water-shed is wooded and contains no population. The land in the immediate vicinity of the spring is fenced in and controlled by the owners of the spring. Water is collected in a cemented reservoir covered with a tight roof, and flows by gravity through block-tin pipe to a bottling house. Water is sold in bottles in Boston, Framingham, Natick and other principal cities and towns in eastern Massachusetts.

Brockton, Indian Spring. — Situated about one quarter of a mile north of East Ashland Street and one-half of a mile east of North Quincy Street, near the Abington line. The water-shed consists of uninhabited woodland. Water is collected in a reservoir excavated from the ledge and covered by a small spring house, and is distributed in cans filled at the spring by means of a pump. Sold in Brockton.

Pepperell, Pepperell Spring. — Situated in the valley of Gulf Brook, near Chestnut Hill Street, in westerly part of town. The water-shed consists chiefly of woodland. A pine grove near the spring is used as a picnic ground, but drainage from it is said to be diverted by means of underdrains, which discharge into a brook below the spring. Water is collected in a cement pipe 24 inches in diameter and 6 feet deep, sunk through sand to rock and covered by a spring house. The bottles in which the water is distributed

are filled by means of block-tin and glass siphons. Sold principally in Pepperell and to some extent in Worcester, Boston and other cities.

Medford, Fulton Natural Spring. — Situated about 500 feet east of Fulton Street, on an uninhabited rocky hillside. Water is collected in a cemented reservoir 4 feet in diameter and 6 feet deep, the bottom being upon ledge. The reservoir is covered by a spring house, and bottles are filled by means of a dipper. Sold in Boston and the suburbs north of the city.

Sutton, Calumet Mineral Spring. — Situated near the Sutton road, a short distance from the Oxford line. The water-shed is uninhabited and consists of pasture and woodland. Water is collected in a cemented reservoir 10 feet in diameter and 6 feet deep, covered by a spring house, and is pumped through rubber hose to a small sand filter, through which it is passed for the purpose of removing the iron contained in the water. The filtered water is sold in bottles in various places in Massachusetts.

Concord, Concord Spring. — Situated 150 feet north of Main Street, in the westerly part of Concord. Water-shed consists of grass and cultivated lands, and there are four houses with outbuildings situated at a considerable distance from the spring, drainage from some of which may find its way toward the spring. Water is collected in an uncemented stone basin 10 feet in diameter and 5 feet deep, covered by a wooden platform. Bottles are filled on the platform over the spring by means of a pail. Sold in Concord.

Hingham, Mt. Blue Spring. — Situated in the south-easterly portion of the town, south-west of Mt. Blue road. Water-shed, uninhabited woodland. Water is collected in a cemented reservoir protected by a spring house, and is distributed in bottles which are filled by means of a pail from the spring. The principal sales are to the summer residents at Scituate, Cohasset and Hull.

Middleborough, Nemasket Spring. — Situated 700 feet west of the Nemasket road, about two miles north of the Middleborough post-office. The water-shed contains four houses and three barns, the nearest being about 400 feet distant from the spring. Water is collected in a 24-inch cast-iron pipe 10 feet in length situated in a spring house. Bottles are filled by means of a tin dipper. Sold in Middleborough, Boston, Brockton, and summer resorts on Cape Cod.

Methuen, Abbott's Spring. — Situated 1,000 feet north of Pleasant Valley Street, 1,200 feet east of Milk Street. This spring is a tubular well 65 feet deep. The water-shed consists of uninhabited woodland and pasture-land. Water flows from the well and the bottles are filled in the open field through a rubber tube attached to an iron pipe. Sold in Lawrence.

Easton, Simpson Spring. — Situated half a mile west of Washington Street and half a mile south of Depot Street in South Easton. The water-shed is uninhabited woodland. Water is collected in a cement pipe 30 inches in diameter and 3 feet deep, located in a bottling house. Water is drawn from the spring by a pump and is distributed from tanks and in bottles. Sold in Brockton, Boston, Taunton, Middleborough, Randolph, Canton, Stoughton and Braintree.

Chelmsford, Golden Cove Spring. — Situated 700 feet south of Syndicate road and 800 feet west of Stedman Street. Water-shed consists chiefly of grass-land, and contains five houses within half a mile of the spring, the nearest of which, with outbuildings, is about 800 feet distant. Water is collected in an open basin about 6 feet in diameter, unprotected from surface water, from which bottles are filled by means of a dipper. Sold in Lowell.

Millbury, Howe's Spring. — Situated 500 feet west of the junction of Howe's and Millbury avenues. The water-shed consists of uninhabited woodland, but the land immediately surrounding the spring is used as a picnic grove. Water is collected in an open basin 25 feet square and about 6 feet deep, in the centre of which is a 36-inch cement pipe extending to a depth of 6 feet below the bottom of the basin. During the dry summers of 1899 and 1900 there was no water in the large basin and the sale of water from this spring was suspended. The spring is covered by a wooden building. The bottles in which the water is distributed are filled from the spring by means of a tin pail. Sold in Worcester.

Natick, Lang Moore Spring. — Situated in a meadow, 400 feet south-west of Pine Street and half a mile south-east of North Main Street. The water-shed is uninhabited and consists chiefly of woodland. Water is collected in an open basin 12 feet long, 6 feet wide and 3 feet deep, with plank sides through which surface water may enter. The spring contains abundant animal and vegetable growths. The tank wagons in which the water is distributed are filled at the spring by means of a wooden pump. Sold in Natick.

Dracut, Baltic Spring. — Situated 1,000 feet west of Mammoth road, half a mile above Collinsville. The water-shed consists of uninhabited rocky woodland. Water is collected in a cemented reservoir 5 feet square and 3 feet deep, resting upon rock and covered by a spring house. From this reservoir it flows through 500 feet of tin-lined lead pipe to a point below the spring, where bottles are filled. Sold in Lowell.

Amesbury, Lombard Spring. — Driven well 60 feet deep, situated in southerly part of town, 60 feet south of Lombard Avenue and 200 feet west of Main Street, by the side of a small brook. Water-shed of brook contains eight or ten houses, four or five barns, several hen-yards and a cultivated field within 500 feet of well on the opposite side of the brook. Well overflows continuously and bottles are filled from overflow pipe. Sold in Amesbury.

Natick, Leland Spring. — Situated 400 feet north-west of the corner of Speen and Pond streets, in the westerly part of the town. The water-shed consists of uninhabited woodland. Water issues from the ledge and is collected in an open basin 3 feet in diameter and 1 foot deep, unprotected from surface water. Bottles are filled at the spring with a dipper. Sold in Natick, Wellesley and neighboring towns.

Mattapoisett, King Philip's Mineral Spring. — Situated 600 feet west of Rochester road, in the north-westerly part of the town. The water-shed consists principally of woodland but contains one house at a long distance from the spring. Water is collected in a cemented reservoir 3½ feet square, covered by a spring house, from which it flows to a second reservoir beneath the floor of the spring house. Bottles in which the water is distributed are filled from the overflow pipe of the second reservoir. Sold in Mattapoisett, New Bedford, and the summer resorts on Cape Cod.

Williamstown, Sand Springs. — Situated 600 feet north of Broad Brook and one-half mile east of Hoosick River. Water-shed consists of uncultivated and uninhabited land, except in the immediate vicinity of the spring, where there is a sanitarium consisting of a group of six buildings. Four of these buildings are so situated that they might naturally drain toward the spring, the other two being below the spring. Sewage from the buildings is, however, discharged into the brook below the spring through a tile pipe having cemented joints. Water is collected in an uncovered stone reservoir about 20 feet square and 9 feet deep, and flows through an iron

pipe into a bottling house where the bottles in which the water is distributed are filled. Sold in various parts of Massachusetts.

Stoneham, Vishnu Mineral Spring. — Situated 1,000 feet north of Spring Street. The water-shed consists chiefly of woodland but contains two or three houses at a long distance from the spring. Water is collected in an iron pipe 2½ feet in diameter and 4 feet deep, covered by a spring house. Jugs and tanks are filled outside of the spring house from a pump. Sold in Stoneham, Wakefield and Boston.

Belmont, Belmont Natural Spring. — Situated about 1,000 feet north of Winter Street and 1,200 feet north-west of Marsh Street. The water-shed is principally grass-land used for park purposes and includes some cultivated land but is uninhabited. Water is collected in a small reservoir cut out of the rock, and passes through 60 feet of tin-lined lead pipe to a bottling house, where the bottles are filled from a pump. Sold in the westerly suburbs of Boston, and in Beverly, Nahant, Somerville, Newton, Waltham and Arlington.

South Hadley, Mt. Holyoke Lithia Spring. — Situated at base of Mt. Holyoke, in northerly part of town. The water-shed consists of uninhabited woodland. Water is collected in a tiled reservoir 5 feet in diameter and 3 feet deep, covered with a wire netting. The bottles are filled in the field from a block-tin pipe 25 feet in length, through which the water flows by gravity. Water is sold in Holyoke and many other places in Massachusetts.

Lawrence, Valpey's Spring. — Situated 1,000 feet west of Beacon Street and 400 feet north-west of the Lawrence branch of the Boston & Maine Railroad at South Lawrence. The water-shed consists of uninhabited woodland. Water is collected in two earthen pipes, each enclosed in a separate spring house. Bottles are filled from pumps. Sold in Lawrence.

Norwood, Norwood Spring. — Situated 100 feet east of Neponset Street, about a quarter of a mile south of Pleasant Street. The water-shed consists of cultivated fields and grass-land. Water is collected in a well 4 feet in diameter and 6 feet deep, covered by a wooden platform. Water is distributed in bottles which are filled from the spring by means of a tin pail. Sold in Norwood.

Medford, Middlesex Mountain Spring. — Situated about 300 feet north of Fells Parkway West, at the base of a rocky cliff. The water-shed consists of uninhabited woodland. Water is collected in

a cemented reservoir 5 feet deep, enclosed in a wooden building and is conveyed through 150 feet of galvanized iron pipe to a bottling house near Fells Parkway West. Sold in bottles in Boston and the suburbs north of the city.

Franklin, Sunnyside Spring. — Situated 400 feet west of Maple Street, at the base of a bluff which rises abruptly from a meadow. There are no houses above the spring within half a mile of it. Water issues from the rock and is collected in an uncovered, shallow basin which may receive considerable surface water. It is distributed in bottles which are filled from glass tubes inserted through a small wooden dam across the lower end of the basin. Sold in Franklin.

Danvers, Sager's Spring. — Situated about 1,500 feet west of the junction of Pine and Otis streets. The water-shed consists of uninhabited pasture-land. Water is collected in an open concrete reservoir 8 feet in diameter. Sold in Salem.

West Springfield, Massasoit Spring. — Situated in the valley of Bear Hole Brook, in the westerly part of the town, at the foot of a steep sandy slope. The water-shed consists of grass-land and woodland, the only buildings within half a mile of the spring being a house and barn about 600 feet distant, drainage from which may not reach the spring. Water is collected in an 18-inch pipe 7 feet in depth, from which it flows by gravity through 150 feet of iron pipe and 10 feet of rubber hose to a tap, where the jugs in which the water is distributed are filled. Sold in Springfield.

Gloucester, Magnolia Spring. — Situated in the western part of the city of Gloucester, at the foot of Bond's Hill. Water-shed wooded and uninhabited. A cottage, used only in summer, is located 50 feet south-east of the spring, but probably does not drain towards it. Water is collected in a covered cemented reservoir 6 feet wide, 8 feet long and 8 feet deep. Bottles are filled from a platform over the spring by means of a pump. Sold in Gloucester and Magnolia.

Weymouth, Garfield Spring. — Situated 800 feet west of Summer Street and 700 feet south of Walnut Avenue at the base of a bluff. On the bluff above the spring is a base-ball ground and a grove which is frequented by the public. The nearest permanent source of pollution is a privy vault and manure pile about 450 feet from the spring. Water is collected in a stone reservoir and flows through 20 feet of galvanized iron pipe to the bottling house. Sold in Weymouth.

Group II.

Lowell, Mt. Pleasant Spring. — Situated about 300 feet south of Westford Street and 100 feet west of Stedman Street. The water-shed consists chiefly of woodland and contains no houses within 950 feet of the spring. Water is collected in a cemented reservoir 3 feet square and 8 feet deep, covered by a spring house. Bottles in which water is distributed are filled by means of a tin pail. Sold in Lowell.

Scituate, Beaver Dam Spring. — Situated 60 feet north of Willow Street and 50 feet from the New York, New Haven & Hartford Railroad. The water-shed is mainly pasture land but contains one cultivated field within 200 feet of the spring. The nearest house on the water-shed is a quarter of a mile away. Water rises in a cemented cistern 4 feet in diameter and 2½ feet deep, covered by an open pavilion. From the reservoir the water flows through 30 feet of galvanized iron pipe to a bottling house, where the bottles in which the water is distributed are filled. Water is sold in the towns between Scituate and Quincy.

Quincy, Shawmut Spring. — Situated about one-half mile south of the corner of Edge Hill Road and Pleasant Street in the northerly part of the city. The water-shed is rocky. A privy vault and a stable containing two horses are about 160 feet from the spring. Water is collected in a well of drain pipe two feet in diameter, and 13 feet deep. From the spring the water flows through 20 feet of iron pipe to a pump in the bottling house. Water is distributed in bottles in Quincy, Milton and Boston.

Stoneham, Middlesex Fells Spring. — Situated 900 feet north of Pond Street, near the Melrose line. The water-shed, a large part of which is included in the Middlesex Fells Reservation, is steep and rocky, and contains only one house situated at a considerable distance from the spring. Water is collected in a cemented reservoir 5 feet square and 6 feet deep, resting on rock and situated in a bottling house. Water is pumped from the spring through 20 feet of block-tin pipe, and is distributed in bottles in Melrose, Everett, Malden and Boston.

Woburn, Silver Seal Spring. — Situated near the corner of Holton and Nashua streets. There are two houses within 500 feet of the spring and at a considerably higher elevation. Holton Street runs

within 100 feet of the spring and 15 feet above it. Water is collected in a reservoir 8 feet square and 4 feet deep, located in a spring house. Water is distributed in bottles filled from the over-flow pipe outside of the spring house. Sold in Winchester and Woburn.

Lynn, Electric Spring. — Situated at the corner of Linwood and Cliff streets. The water-shed consists principally of woodland, and contains one or, possibly, two houses, the nearest one, with a privy vault and outbuildings, being about 150 feet from the spring. Water is collected in a well 18 feet in diameter and 12 feet deep, covered with a shed, and is pumped into tanks from which it is distributed to factories in Lynn.

Arlington, Robbins Spring. — Situated on Robbins road at Arlington Heights. The springs are situated on a steep slope south of Massachusetts Avenue, three of them being about 1,600 feet, and two about 900 feet, from the avenue. The water-shed consists mainly of uncultivated land, but near the summit of the hill there are several houses, and the Robbins Spring Hotel is possibly on the water-shed of the two lower springs. The sewage of this hotel is conveyed to a point outside of the water-shed. A tract of land immediately above the springs has been reserved by the operators of the spring. The three upper springs are covered by wooden buildings, and the water is collected in a main spring house from which it is conveyed to a bottling house on Massachusetts Avenue through about 1,500 feet of cement-lined iron pipe. Water from the two remaining springs is collected in small covered reservoirs situated near the pipe line from the upper springs to the bottling house. Each of these springs is covered with a wooden cover. Sold in Boston and suburbs.

Stoneham, Beach Hill Spring. — Situated about 800 feet from Green Street and about a quarter of a mile north of Spring Street. The water-shed consists of woodland and the nearest houses are a long distance from the spring. Water is collected in 24-inch cement pipe 6 feet in depth, covered by a spring house, and is distributed in tank wagons and bottles which are filled at the spring by means of a pump. Sold in Stoneham, Medford, Somerville and Wakefield.

Gloucester, Niagara Spring. — Situated in northerly part of Gloucester, 60 feet south of Reynard Street and about 500 feet west of Cherry Street. Spring is situated in a cultivated field, and the

water-shed contains six houses and three barns within 500 feet, the nearest of which are a barn 110 feet and a privy vault 160 feet distant. Water collected in an 18-inch cement pipe 2 feet deep and not completely protected from surface water. Sold in Gloucester in summer.

Needham, Bird's Hill Spring. — Situated 100 feet south of Great Plain Avenue and about 600 feet west of the Needham Boulevard. The water-shed contains two houses with stables and outhouses, the nearest source of pollution being a cesspool and privy vault about 200 feet from the spring. Water is collected in a cemented reservoir 5 feet in diameter and 8 feet deep, resting upon ledge and located within a bottling house. Bottles are filled from a pump. Sold in Boston and Needham.

Wilbraham, Wilbraham Mountain (formerly Faculty) Spring. — Situated near Faculty Street, about a quarter of a mile west of Wesleyan Academy. The water-shed contains about thirty houses and ten barns within a quarter of a mile of the spring, but none nearer than 700 feet. The spring is immediately surrounded by grass-land. Water is collected in a subterranean reservoir from which it flows about 300 feet through a cement pipe into an open wooden barrel, unprotected from surface water. Water is distributed in jugs which are filled from the barrel by means of a dipper. Sold in Springfield.

Winchester, Fairmont Spring. — Situated 200 feet west of Arlington Street and a quarter of a mile north of the Arlington line. The water-shed is pasture-land, the nearest house being about 1,000 feet from the spring. A barn containing eighteen cattle is situated 500 feet from the spring at an elevation considerably above it, and the cattle are pastured in a field a short distance from the spring and watered at a trough filled from the pump at the spring. Water is collected in a cemented reservoir 6 feet in diameter and 5 feet deep, resting on rock and provided with a wooden cover. Bottles in which water is distributed are filled from the pump at the spring. Sold in Winchester, Medford and Cambridge.

Revere, Columbia Lithia Spring. — Situated 80 feet north of Yeaman Street, near the corner of Day and Kilburn streets. The water-shed contains about seven houses, most of which are connected with the sewers. A cesspool about 400 feet away may drain toward the spring. Water is collected in a cemented reservoir 10 feet square and 10 feet deep, within a large bottling house, and is

pumped through 20 feet of galvanized iron pipe to a bottling room. Sold in bottles in Everett, Chelsea, Somerville, Malden, Revere, Cambridge and Lynn.

New Bedford, Howland Spring. — Situated in a pasture in the westerly part of the city, near the Dartmouth line. The water-shed contains a few houses, none of which are near the spring. Water is collected in a shallow basin 6 feet in diameter, covered by a spring house, and is unprotected from surface water. Bottles are filled from a pump. Sold in New Bedford.

Brockton, Brockton Mineral Spring. — Situated 600 feet east of North Quincy Street and a quarter of a mile north of East Ashland street. The territory in the vicinity of the spring consists chiefly of woodland. There are no buildings in the neigborhood of the spring. Water is collected in a basin 3 feet square and 6 feet deep, excavated in ledge and covered with a wooden building but not protected from surface water. The jugs in which the water is distributed are filled by means of a pail. Sold in Brockton.

Methuen, Crystal Mineral Spring. — Situated about 300 feet north-east of Hampsted Street, 1,000 feet north of Howe Street. The water-shed includes several houses, barns and cultivated fields, the nearest source of pollution being a barn and a privy vault, about 280 feet from the spring. Water rises in a cemented reservoir 4 feet in diameter and 6 feet deep, closed with a wooden cover and situated inside of a bottling house. The bottles in which the water is distributed are filled by means of a tin pail. Sold in Methuen and Lawrence.

Chelmsford, Robin's Hill Spring. — Situated 150 feet west of Acton road, half a mile south-west of Chelmsford Centre. The water-shed consists chiefly of grass-land and pasture-land but contains one house and barn about 350 feet from the spring. Water is collected in a reservoir 4 feet wide, 5 feet long and 6 feet deep, resting on ledge and covered with a wooden platform. Bottles in which the water is distributed are filled at the spring by means of a pail. Sold in Lowell.

Lawrence, Bodwell Spring. — Situated 250 feet north of Haverhill Street, on the south-east slope of Kearsage Heights. The water-shed consists chiefly of orchard and grass-land. Water is collected in a small stone reservoir, from which it flows through 200 feet of lead pipe to the kitchen of the house where the bottles in which the water is distributed are filled. Sold in Lawrence.

Tewksbury, Clark's Ledge Spring. — Situated about 1,000 feet west of Clark's road and half a mile south of Andover Street. The water-shed of the spring consists chiefly of grass-land, there being no houses upon it within 1,000 feet. Water is collected in a 48-inch earthen pipe 12 feet deep, resting on ledge, the top being cemented over and covered by a shed. Bottles are filled directly from the spring by a pump. Sold in Lowell and Tewksbury.

Group III.

Abington, Highland Spring. — Situated about 600 feet east of the Brockton line, near Quincy Street. The water-shed contains cultivated land and several farm buildings, the nearest of which are about 300 feet from the spring. Water is collected in a cemented reservoir 5 feet square and 8 feet deep, closed by a wooden cover. The tanks in which the water is distributed are filled by means of a pump. Sold in Brockton.

Methuen, Burnham Spring. — Situated 1,000 feet south of Orchard Street, in the south-easterly part of the town. The water-shed contains two houses not far from the spring. Water is collected in a 20-inch akron pipe 30 feet deep, covered with boards, and flows by gravity through 125 feet of oxidized iron pipe into a tank, located in the bottling house. The bottles and jugs in which the water is distributed are filled from this tank. Sold in Lawrence, Boston, Malden and Melrose.

Lawrence, Knowles' Diamond Spring. — Situated 200 feet south of Andover Street and 200 feet east of Beacon Street in South Lawrence, near the Andover line. The water-shed contains several houses and barns, the nearest of which is the house of the operator of the spring, situated 75 feet distant and considerably above it. Beyond this house are cultivated fields. A cesspool connected with this house is about 100 feet from the spring, and a barn in which four horses are kept adjoins the house. Water is collected in a cemented reservoir 7 feet in diameter and 9 feet deep, located in a bottling house. Bottles are filled by means of a pump. Sold in Lawrence.

Whitman, Goulding's Spring. — Situated about 250 feet south of Temple Street and 100 feet west of Corthell Avenue. The water-shed contains a number of dwelling-houses, the nearest of which is within 200 feet of the spring. The nearest sources of pollution are privy vaults 150 and 170 feet from the spring. Water is collected in a

cemented reservoir 2½ feet in diameter and 7½ feet deep, located in a bottling house, and is pumped through galvanized iron and tin pipe to a point outside of the building, where the tanks in which the water is distributed are filled. Sold in Whitman and Brockton.

Brockton, Granite Rock Spring. — Situated about 450 feet from Cary Street and 1,300 feet from Winter Street. The water-shed contains some cultivated fields and includes several houses within a short distance of the spring. The nearest source of pollution is a privy vault 140 feet from the spring. Water is collected in a cemented reservoir 7 feet square and 2½ feet deep, resting upon ledge and enclosed in a spring house. Water is pumped into tank wagons which are drawn up near the spring, and from them delivered to consumers in Brockton.

Wakefield, Montrose Spring. — Situated 150 feet south of Salem Street, 500 feet east of the railroad crossing of the Boston & Maine Railroad. One house, barn and privy 150 feet away and a hen-yard 100 feet away drain directly toward the spring. Two houses 50 and 300 feet away may drain toward the spring. Drainage from a barn 135 feet away naturally flows toward the spring but is intercepted by a ditch. Water is collected in a cemented reservoir 6 feet square and 6 feet deep, in the bottom of which is an earthen pipe, 3 feet in diameter, extending 2 feet below the bottom of the reservoir. The reservoir is closed by a wooden cover. Bottles are filled from a pump at the spring. Sold in Wakefield.

Quincy, Puritan Spring. — Situated near the corner of Robertson and Willard streets, in West Quincy. The water-shed contains a large number of houses and stables, many of which are located near the spring. The nearest sources of pollution are a house, privy and hen-yard about 100 feet from the spring and at a considerably higher elevation. Water is collected in a 24-inch cement pipe 4 feet deep, covered by a small spring house but unprotected from the entrance of surface water. Bottles are filled at the spring by means of a pail. Sold in Boston and Quincy.

Fitchburg, Pearl Hill Mineral Spring. — Situated about 1,000 feet east of Pearl Hill road and a quarter of a mile south of Fisher road. The water-shed contains several houses and cultivated fields, none of which are within 500 feet of the spring. Water is collected in a 24-inch cement pipe 5 feet deep, provided with a wooden cover.

Bottles are filled at the spring by means of a dipper. Sold in Fitchburg.

Chelsea, Mount Washington Spring. — Situated near the corner of Mount Washington Avenue, Fenno and Garfield streets. The water-shed contains a large number of houses, all of which are stated to be connected with the sewers. The nearest source of pollution is a stable within 250 feet of the spring. Water is collected in a cemented reservoir 6 feet in diameter and about 12 feet deep, within a large spring house, and is pumped through 20 feet of block-tin pipe to a bottling room. Sold in Boston, Cambridge, Somerville, Chelsea, Everett, Revere and Winthrop.

Scituate, Egypt Spring. — Situated 800 feet south-west of Bay Street, about a mile north of Willow Street. The water-shed consists chiefly of uncultivated and uninhabited land, but there are four houses and barns within 1,000 feet of the spring, the nearest being about 800 feet distant. Water is collected in a covered cemented reservoir 5 feet in diameter and 5 feet deep, from which it flows through 30 feet of tin-lined lead pipe to the bottling room. Sold in bottles in Scituate, Cohasset and Boston.

Danvers, Lakoo Indian Crystal Spring. — Situated about 100 feet east of Pine Street and 90 feet south of Otis Street. The water-shed contains several houses and a barn, the nearest house being about 60 feet from the spring on the top of the short steep slope, at the base of which the spring is located. Water is collected in a cement pipe 2½ feet in diameter and about 2 feet in depth. Sold in Beverly, Peabody and Danvers.

Westford, Nashoba Spring. — Situated 300 feet west of the Nashua and Acton branch of the Boston & Maine Railroad, about three-quarters of a mile north of East Littleton station. The water-shed consists chiefly of grass-land and orchards, the nearest house upon it being about a quarter of a mile from the spring. Water is collected in a small cemented reservoir, built upon the ledge from which the water issues and partly protected by a wooden cover. Bottles are filled at the spring by means of a pail. Sold in Westford, Lowell and Boston.

Springfield, Ingersoll Grove Spring. — Situated in Ingersoll Grove, a small public park of the city of Springfield. The water-shed is very thickly built up and there are many houses within a short distance of the spring, all of which, however, are connected with sewers.

Water is collected in a subterranean reservoir of brick, from which it flows through 50 feet of 4-inch earthen pipe to the bottom of a small valley in the park, where it is used by the public for drinking purposes. Water is distributed in Springfield from tank teams which are filled by means of pails.

Weymouth, Avonia Spring. — Situated near the corner of Commercial and Essex streets. The water-shed contains several houses, the nearest source of pollution being a cesspool about 175 feet from the spring. Water is collected in a cemented reservoir 3 feet deep covered by a spring house. From this reservoir it flows through 20 feet of galvanized iron pipe to a tap in the open field, where the bottles are filled. Sold in Weymouth, Quincy, Braintree, Boston, Brookline, Cambridge and Malden.

Duxbury, Myles Standish Spring. — Situated in the south-easterly part of the town, a short distance from the salt water on Standish Beach. The water-shed contains a large hotel on the summit of a ridge about 150 feet distant and two summer cottages. The drainage from the hotel is disposed of on the opposite side of the ridge but may drain toward the spring. The privies connected with the cottages are so situated that the water of the spring may not be affected by them. Water is collected in a tiled reservoir 10 feet in diameter and 10 feet deep, covered with a glass roof. In the bottom of this reservoir is a 36-inch earthen pipe 10 feet in depth. Water is pumped from the spring through about 50 feet of galvanized iron pipe to a tank in a bottling establishment. Sold in Duxbury.

Malden, Linden Mineral Spring. — Situated near the junction of Salem and Lynn streets, in Linden Highlands. The water-shed, which is steep and rocky, contains about ten houses and two barns. A privy vault and cesspool are located about 150 feet from the spring and 30 feet above it. Water is collected in a cemented reservoir about 10 feet deep, covered by an open pavilion, and flows by gravity through 100 feet of galvanized iron pipe to a bottling house on Salem Street. Sold in Everett, Malden, Winthrop, Somerville and Boston.

Belmont, Trapelo Spring. — Situated near the corner of Common Street and Trapelo road, near the Watertown line. The water-shed contains several houses, the nearest being about 250 feet distant from the spring. Water is collected in a cemented reservoir 8 feet in diameter and 12 feet deep, closed with an iron cover. Bottles

are filled from a pump in a bottling room about 20 feet distant. Sold in Belmont.

Milton, Milton Spring. — Situated near the corner of Randolph Avenue and Hillside Street. The water-shed contains several houses and barns near the spring, the nearest source of pollution being a privy vault and hen-house about 50 feet from the spring. Water is collected in an earthen pipe 3 feet in diameter and 23 feet deep, provided with a wooden cover and situated in a spring house. Bottles are filled from a pump in the spring house. Sold in Milton.

Lawrence, Stevens Spring. — Situated in a wood yard on Wendell Street, in a thickly built-up portion of the city. The buildings in the vicinity of the spring are all said to be connected with sewers. A cemetery about 400 feet distant may drain toward the spring. Water is collected in a cemented reservoir 5 feet in diameter and 7 feet deep, provided with an iron cover, but surface water may enter the spring at times. Water is drawn from the spring through 30 feet of akron pipe to a point on Wendell Street, where the bottles are filled and where water is provided for public drinking purposes. Sold in Lawrence.

Natick, Pequot Spring. — Situated 600 feet north of North Main Street, in the valley of Snake Brook in Cochituate. The water-shed consists of pasture and cultivated land and includes twelve houses within about 1,000 feet of the spring, the nearest of which, with a privy vault and a stable in which five horses are kept, is within about 150 feet. Water is collected in a reservoir 5 feet square and 5 feet deep, built into rock, and covered with a shed. It is distributed in cans filled by dipping them into the spring. Sold in Natick, Framingham and Wayland.

Belmont, Belmont Crystal Spring. — Situated 1,600 feet north of the corner of Brighton Avenue and Pleasant Street. The water-shed consists chiefly of cultivated fields and pasture-land, and there are no houses within half a mile of the spring. Water rises in a cemented reservoir 15 feet in diameter and 15 feet deep, the bottom resting upon rock and the top being closed with an iron cover, and passes through 1,560 feet of tin-lined lead pipe to a bottling house near Pleasant Street, where the bottles in which the water is distributed are filled. Sold in Arlington, Cambridge, Somerville, Malden, Melrose and Boston.

Springfield, Hygeia Spring. — This water is obtained from two

10-inch tubular wells driven through 45 feet of gravel and clay and then through rock, one to a depth of 425 feet and the other to a depth of 200 feet. The wells are situated beneath a brewery near the corner of State and Benton streets. There are several houses and stables near the wells some of which are not connected with the sewers. Water from the wells is pumped into galvanized iron tanks, from which it is distributed in Springfield.

Haverhill, Smiley's Spring. — Situated about 1,000 feet east of the main line of the Boston & Maine Railroad, a quarter of a mile south of the New Hampshire line, at the lower edge of a large meadow which borders Little River. There are several houses on the higher land above the meadow but none within 800 feet of the spring. Water is collected in a brick reservoir 4 feet in diameter, covered with loose boards. Bottles are filled by means of a tin dipper. Sold in Haverhill.

Lexington, Katahdin Spring. — Situated at the bottom of a steep slope 70 feet east of Wood Street, in the valley of a small brook. The water-shed consists partly of cultivated land and partly of woodland. The only immediate source of pollution is a dwelling-house and privy within about 150 feet of the spring. Water is collected in a small open reservoir 2 feet deep, unprotected from surface water, and which contained a growth of organisms at the time of inspection. From the reservoir the water passes by gravity through 350 feet of galvanized iron pipe to a bottling house. Water is distributed in bottles in Boston, Somerville, Cambridge, Winthrop and Arlington.

Lynn, Lovers' Leap Spring. — Situated on Lovers' Leap Avenue, about 150 feet south of the corner of Everett Street. The water-shed contains a large number of houses, all of which are provided with cesspools or privy vaults, and many of them are within a short distance of the spring. Water is collected in an uncemented stone reservoir 3 feet in diameter, located about 16 feet beneath the surface of Lovers' Leap Avenue, and is conveyed through 200 feet of galvanized iron pipe to a bottling house. Water is distributed from tanks to factories in Lynn and is also sold in bottles.

Lowell, Leland Spring. — Situated in front of a house on Fremont Street, 300 feet north of Sixth Street in Centreville. The territory in the vicinity of the spring is thickly built up but many of the houses are connected with sewers. Water is collected in a stone

reservoir said to be 15 feet in diameter and 35 feet deep, which is protected by an iron cover, but which may receive surface water. From this reservoir it flows through 175 feet of iron pipe to a house on Beach Street, where the tanks in which the water is distributed are filled. Sold in Lowell.

Whitman, Whitman Spring. — Situated about 500 feet east of Washington Street in northerly part of town. The water-shed contains a number of dwelling-houses and barns the nearest of which are about 500 feet distant, and cultivated land close to the spring. Water is collected in a cemented reservoir 3 feet in depth, covered by a small wooden shed. Water is distributed in tin cans filled from the spring by means of a pump, and is sold in Whitman and Abington.

Lynnfield, Deep Rock Spring. — Situated beneath a stable on Forest Avenue, about 800 feet from the Lynn road. The water-shed contains two houses and two barns within 400 feet of the spring. Water is collected in an 8-inch galvanized iron pipe, 8 feet in depth, resting upon a ledge of serpentine rock. Bottles in which the water is distributed are filled from a pump. Sold in Boston and Lynn.

Lowell, Highland Spring. — Situated east of Hawthorne Street, about 300 feet from Pine Street. The surrounding territory is cultivated and there is a house and privy within 60 feet of the spring. Another house and barn are situated about 150 feet from the spring. Water is collected in a 24-inch earthen pipe, 9 feet deep, situated in a spring house. Bottles in which the water is distributed are filled by dipping up the water in a tin pail. Sold in Lowell.

Natick, Maher's Spring. — Situated in South Natick, about 300 feet east of Union Street and about 100 feet south of Brook road. The water-shed consists of grass-land and contains five houses within 500 feet of the spring, the nearest of which is about 50 feet distant. Water is collected in an uncemented, open stone reservoir 3 feet in diameter and 4 feet deep, resting upon ledge and not protected from surface water. Barrels are filled at the spring by means of a pail and taken to shoe factories in Natick.

Lawrence, Hygiene Spring. — Situated 50 feet south of Garden Street and 400 feet west of Prospect Street. The water-shed is steep and contains three or four houses which are probably connected with sewers, and one stable 225 feet from the spring. The water rises in a reservoir 6 feet square and 7 or 8 feet deep, closed with a

wooden cover, and is drawn by gravity through 40 feet of galvanized iron pipe to the yard of the Russell Paper Company, where the bottles in which the water is distributed are filled. Sold in Lawrence.

Stoneham, Chapman Crystal Mineral Spring. — Situated 600 feet north of Spring Street and three-quarters of a mile east of the centre of the town, at the foot of a small steep bluff. There are several houses and a barn on the bluff above the spring, the nearest being about 500 feet distant. Water is collected in a cement pipe 2½ feet in diameter and 10 feet deep, covered by a spring house. Water is pumped into tanks, and bottles are filled from the spring by means of a pail. Sold in Stoneham, Winchester, Medford, Somerville, Everett, Malden, Melrose, Wakefield and Boston.

Boston, Undine Spring. — Situated in a pasture 500 feet west of Lake Street and 350 feet north of Appleton road, in Brighton. The water-shed contains several houses and barns, the nearest house, with its cesspool and privy vault, being within 300 feet of the spring and at a considerably higher elevation. A barn containing six or seven cows is at about the same distance from the spring. Water is collected in a cemented reservoir 10 feet in diameter, resting upon rock and covered by a wooden roof. Water is distributed in bottles and jugs which are filled from the overflow pipe in the pasture. Sold in Boston.

Brockton, Brockton Crystal Spring. — Situated about 1,200 feet west of Pearl Street and 400 feet south of Pleasant Street. The water-shed in the immediate vicinity of the spring consists of woodland, but at a greater distance are cultivated fields. There are about ten houses with outbuildings on the water-shed of the spring, the nearest one being within about 300 feet. Water is collected in a cemented reservoir 3 feet deep, resting on ledge and covered with a platform but not protected from surface water. Tank teams in which the water is distributed are filled by means of a pump. A small amount of water is also distributed in bottles. Sold in Brockton.

Swampscott, Bassett's Spring. — Situated near the corner of Essex Street and Essex Place. The water-shed contains a large number of houses and stables, with privy vaults and cesspools, many of which are near the spring. Water is obtained from a tubular well 2 inches in diameter, driven through clay and hardpan to a depth of 26 feet; and is pumped through 120 feet of galvanized iron pipe to

wooden tanks, in which it is distributed to factories in Lynn. Part of the water is distilled and sold in the neighboring towns.

Holbrook, Mingo Spring. — Situated at the foot of a steep slope about a quarter of a mile west of North Franklin Street, in the northerly part of town. The water-shed consists chiefly of pasture land but includes, also, several buildings. The nearest source of pollution is a piggery about 300 feet from the spring. Water is collected in a roughly stoned-up basin about 2 feet in depth, which contains a considerable vegetable growth and is not protected from surface drainage. Water is distributed in tin cans which are filled by dipping them into the water at the spring. Sold in Randolph and Braintree.

Everett, Everett Crystal Spring. — Situated at corner of Chelsea and Ferry streets. The water-shed contains a large number of dwelling-houses and stables, the nearest of which is within about 150 feet. Water is collected in a well 12 feet in diameter and 20 feet deep, beneath the floor of the bottling house, and passes through 30 feet of galvanized iron pipe to the bottling room. Water is distributed in bottles, jugs and tanks, in Boston, Chelsea, Somerville and Everett.

Framingham, Hamilton Mineral Spring. — Situated at the foot of a steep bluff near Bannister Brook, 150 feet west of Speen Street and a quarter of a mile north of Cochituate road. Water is collected in a reservoir 2 feet square and 4 feet deep, covered by an open pavilion. The spring is at such a low level that at times the water of Bannister Brook backs up through the overflow into the spring. This brook receives the effluent from the sewage purification works at Framingham and Natick. At the time the second sample was collected from the spring the water in Bannister Brook was at a level as high as that of the water in the spring. Water is distributed in Natick in bottles which are filled at the spring.

Lexington, Lexington Spring. — Situated 300 feet south of Woburn Street and half a mile east of Massachusetts Avenue. The water-shed contains several houses and one or two barns, the nearest possible source of pollution being a barn considerably above the spring and about 125 feet distant, the cellar of which is covered with concrete. Water is collected in a tiled reservoir 5 feet in diameter and 3 feet deep, covered by a spring house, and the bottles are filled by means of a pump. Sold in Lexington.

Stoneham, Bear Hill Mineral Spring. — Situated in a meadow 200 feet west of Main Street, near corner of South Street. The

water-shed is principally within the Middlesex Fells park reservation. The principal sources of contamination are a house 150 feet away, two barns 100 and 160 feet, a cesspool 110 feet, and hen-yards, containing 300 to 400 hens, from 150 to 350 feet distant from the spring. Water is collected in a cemented reservoir 8 feet square and 8 feet deep, covered by a spring house. Bottles are filled either directly from a pump or from a tank supplied from the pump. Sold in Medford, Stoneham, Melrose and Somerville.

Everett, Belmont Hill Spring. — Situated near the corner of Bradford Street and Belmont Park. The water-shed is thickly built up but many of the houses are connected with the sewers. A cesspool and privy vault are within 150 feet of the spring. Water is collected in an uncemented reservoir 8 feet in diameter and 12 feet deep, covered by a spring house. It is distributed from tank wagons which are filled by means of a pump. A small quantity is also delivered in bottles and jugs. Sold in Boston, Cambridge, Somerville, Brookline, Everett and Malden.

Lexington, Larchmont Spring. — Situated on the south-west side of Larchmont Lane about 180 feet north-west of Revere Street. The drainage area contains one house about 200 feet distant, but several houses on Revere Street, within 300 feet of the spring, may affect its quality. A barn, in which three horses are kept, is located 80 feet from the spring and probably drains toward it, and there are cultivated fields not far from the spring. Water is collected in a 36-inch pipe 22 feet in depth, closed with a wooden cover, and is conveyed through 80 feet of galvanized iron pipe to a pump in the open field, where the bottles in which the water is distributed are filled. Sold in Lexington.

Swampscott, Moose Hill Spring. — Situated near the corner of Beach Avenue and Columbia Street. The water-shed contains many houses and barns, with privy vaults and cesspools, many of which are close to the spring. Water is collected in two stone reservoirs resting upon rock and covered by a spring house. It is pumped through 30 feet of iron pipe into wooden tanks, from which it is distributed. A small quantity of water is also distributed in jugs. Sold in Swampscott and Lynn.

CONSUMPTION

OF

WATER IN CITIES AND TOWNS

IN

MASSACHUSETTS.

CONSUMPTION OF WATER IN CITIES AND TOWNS IN MASSACHUSETTS.

Of the 166 cities and towns in Massachusetts provided with public water supplies, 49 are supplied by gravity, 109 by pumping and 8 both by gravity and pumping. Twenty-three of the towns supplied by pumping are supplied in connection with other towns, making 86 different systems of water works in which all of the water passes through pumps. In nearly all of the towns where water is supplied by pumping, records are now kept of the quantity of water pumped, and in some cases these records extend back to the time when water was first introduced into the city or town. The pumping records in a few cases are probably not reliable, on account of the lack of knowledge as to the actual quantity of water raised by the pumps at each stroke, but in most cases the records are probably very nearly accurate, and they furnish valuable information as to the quantity of water consumed in the various cities and towns supplied by pumping. In one city, which is supplied by gravity, meters have been placed on the main pipes so that the quantity of water consumed in that city is known, but in the other cities and towns supplied by gravity no reliable figures can be obtained as to the quantity of water used.

The average daily quantity of water pumped in each city or town during each year in which records have been kept is given in the following table, together with the population and the consumption of water per person per day. For the sake of comparison the number of services in use in connection with the works, the percentage of services which are supplied with meters and the length of distributing mains in use, as given by the authorities of the various cities, towns and water companies, are also given in this table. The population for other than census years is obtained by direct proportion, assuming that the rate of growth between any two census years is uniform. The figure given in parentheses after the name of a town indicates the year in which a system of water works was first introduced into that town.

METROPOLITAN WATER DISTRICT.*

Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1893, .	708,391	65,590,000	93	-	-	-	1897, .	793,244	80,144,000	101	-	-	-
1894, .	728,254	64,782,000	89	-	-	-	1898, .	815,807	82,914,000	102	137,204	11.2	1467.7
1895, .	748,117	68,882,000	92	-	-	-	1899, .	838,371	91,299,000	109	141,871	11.7	1500.9
1896, .	770,680	77,688,000	101	-	-	-	1900, .	860,934	97,114,000	113	143,821	11.8	1534.5

ABINGTON AND ROCKLAND. (1887.)

1888, .	9,077	247,000	27	1,174	-	33.5	1895, .	9,730	407,000	42	1,908	-	40.7
1889, .	9,275	286,000	31	1,327	-	35.4	1896, .	9,747	371,000	38	1,944	-	40.8
1890, .	9,473	312,000	33	1,450	-	36.6	1897, .	9,764	338,000	34	1,996	-	41.7
1891, .	9,524	293,000	31	1,584	-	39.7	1898, .	9,782	355,000	36	2,039	-	41.8
1892, .	9,575	298,000	31	1,698	-	40.0	1899, .	9,799	446,000	46	2,083	-	41.8
1893, .	9,626	312,000	32	1,788	-	40.4	1900, .	9,816	373,000	38	2,141	-	42.7
1894, .	9,677	365,000	38	1,857	-	40.4							

ANDOVER. (1890.)

1891, .	6,142	177,000	29	462	26	21.0	1896, .	6,279	337,000	54	752	43	24.0
1892, .	6,143	234,000	38	542	32	22.4	1897, .	6,413	317,000	49	787	-	24.5
1893, .	6,143	285,000	46	601	34	23.5	1898, .	6,546	314,000	47	819	70	25.1
1894, .	6,144	323,000	53	654	36	24.0	1899, .	6,679	392,000	59	845	73	25.3
1895, .	6,145	322,000	53	706	39	24.0	1900, .	6,813	407,000	60	876	73	25.8

ATTLEBOROUGH. (1873.)

1894, .	8,144	272,000	33	978	61	28.3	1898, .	10,116	358,000	35	1,315	60	30.3
1895, .	8,288	306,000	37	1,007	58	28.6	1899, .	10,726	365,000	34	1,399	61	30.6
1896, .	8,897	316,000	35	1,069	63	29.6	1900, .	11,335	453,000	40	1,465	65	31.6
1897, .	9,507	353,000	37	1,267	58	29.8							

AVON. (1890.)

1891, .	1,432	41,000	28	185	-	4.8	1896, .	1,649	49,000	29	288	2	6.1
1892, .	1,480	41,000	28	219	1	5.2	1897, .	1,672	48,000	29	299	2	6.5
1893, .	1,528	55,000	36	248	2	5.6	1898, .	1,695	40,000	24	303	3	6.5
1894, .	1,576	60,000	38	264	2	5.6	1899, .	1,718	55,000	33	315	3	7.1
1895, .	1,626	62,000	38	273	2	5.8	1900, .	1,741	56,000	32	325	2	7.2

AYER. (1887.)

1889, .	2,156	55,000	25	160	4	5.3	1895, .	2,101	73,000	35	334	11	6.7
1890, .	2,148	61,000	28	195	5	5.4	1896, .	2,170	69,000	32	342	12	6.8
1891, .	2,139	69,000	32	216	6	5.9	1897, .	2,239	78,000	35	400	15	7.6
1892, .	2,130	67,000	31	278	8	6.1	1898, .	2,308	94,000	41	412	17	7.6
1893, .	2,121	72,000	34	300	9	6.3	1899, .	2,377	94,000	40	428	17	7.6
1894, .	2,111	71,000	34	324	11	6.3	1900, .	2,446	90,000	37	443	30	7.7

* Including the 16 cities and towns in the district as constituted in 1900 and the town of Swampscott, which is now supplied with water from these works. The city of Newton and the town of Hyde Park, included in this table, have thus far been supplied entirely from local sources, and the statistics for these places are also given separately in subsequent tables. The complete list of municipalities included is as follows: Boston, Chelsea, Everett, Malden, Medford, Melrose, Quincy, Somerville, Arlington, Belmont, Nahant, Revere, Swampscott, Watertown, Winthrop, Newton and Hyde Park.

BEVERLY. (1868.)

Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1888, .	10,167	833,000	82	2,166	1	-	1895, .	11,806	809,000	69	2,872	2	60.8
1889, .	10,494	720,000	69	2,241	1	-	1896, .	12,222	874,000	72	2,987	2	61.7
1890, .	10,821	743,000	69	2,313	2	56.2	1897, .	12,637	857,000	68	3,133	2	62.5
1891, .	11,018	779,000	71	2,405	2	57.0	1898, .	13,053	899,000	69	3,199	2	62.8
1892, .	11,215	795,000	71	2,494	2	57.9	1899, .	13,468	961,000	71	3,277	2	63.2
1893, .	11,412	838,000	73	2,617	2	59.6	1900, .	13,884	1,003,000	72	3,330	3	64.0
1894, .	11,609	884,000	76	2,764	2	60.2							

BILLERICA. (1898.)

1899, .	-	-	-	187	29	9.4	1900, .	2,775	52,000	19	209	30	9.7

BRAINTREE. (1887.)

1890, .	4,848	161,000	33	-	-	-	1896, .	5,445	367,000	68	1,001	1	22.1
1891, .	4,941	299,000	61	671	2	-	1897, .	5,579	364,000	65	1,049	1	23.4
1892, .	5,034	323,000	64	763	2	19.1	1898, .	5,713	385,000	68	1,083	1	23.7
1893, .	5,127	289,000	56	842	1	20.7	1899, .	5,847	452,000	77	1,168	1	25.6
1894, .	5,220	324,000	62	901	1	21.4	1900, .	5,981	544,000	91	1,223	1	26.3
1895, .	5,311	308,000	58	948	1	21.6							

BRIDGEWATER AND EAST BRIDGEWATER. (1888.)

1889, .	7,054	61,000	9	268	-	20.3	1895, .	7,580	164,000	22	570	21	20.7
1890, .	7,160	85,000	12	322	-	20.3	1896, .	7,830	168,000	21	602	23	21.5
1891, .	7,244	102,000	14	426	-	20.3	1897, .	8,080	190,000	24	-	-	-
1892, .	7,328	124,000	17	459	15	20.3	1898, .	8,331	200,000	25	-	-	-
1893, .	7,412	145,000	20	511	20	20.4	1899, .	8,581	213,000	25	-	-	-
1894, .	7,496	167,000	22	547	20	20.5	1900, .	8,831	223,000	25	776	100	23.0

BROCKTON. (1880.)

1892, .	29,642	742,000	25	3,473	59	43.7	1897, .	35,924	1,059,000	30	4,829	77	61.3
1893, .	30,816	695,000	22	3,650	62	48.8	1898, .	37,304	1,012,000	28	4,957	79	62.5
1894, .	31,990	885,000	28	3,874	64	50.0	1899, .	38,683	1,137,000	29	5,140	80	64.1
1895, .	33,165	1,095,000	33	4,245	70	54.6	1900, .	40,063	1,175,000	29	5,275	82	65.4
1896, .	34,545	1,087,000	32	4,581	74	56.8							

BROOKLINE. (1875.)

1877, .	7,227	352,000	49	767	-	23.5	1889, .	11,520	768,000	67	1,754	33	44.7
1878, .	7,503	457,000	61	838	-	24.9	1890, .	12,103	877,000	72	1,908	36	47.6
1879, .	7,780	484,000	62	910	-	25.5	1891, .	12,915	979,000	76	2,062	37	50.4
1880, .	8,057	566,000	70	974	-	26.2	1892, .	13,727	1,046,000	76	2,236	40	52.5
1881, .	8,285	485,000	59	1,035	-	28.5	1893, .	14,539	1,214,000	84	2,397	43	58.6
1882, .	8,513	494,000	58	1,082	-	29.5	1894, .	15,351	1,314,000	86	2,549	45	61.2
1883, .	8,741	547,000	63	1,134	4	30.0	1895, .	16,164	1,318,000	82	2,775	45	63.7
1884, .	8,969	568,000	63	1,191	7	30.2	1896, .	16,918	1,348,000	79	2,948	46	65.3
1885, .	9,196	657,000	71	1,278	7	35.6	1897, .	17,672	1,382,000	78	3,141	45	66.6
1886, .	9,777	698,000	71	1,393	9	37.2	1898, .	18,426	1,472,000	80	3,278	47	68.0
1887, .	10,358	763,000	74	1,501	10	38.4	1899, .	19,181	1,772,000	92	3,496	48	73.1
1888, .	10,939	848,000	78	1,631	27	43.8	1900, .	19,935	1,941,000	97	3,592	51	74.0

CAMBRIDGE. (1856.)

YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1875, .	47,838	2,761,000	58	6,570	1	-	1888, .	65,880	4,165,000	63	9,730	2	-
1876, .	48,804	2,443,000	50	6,820	2	-	1889, .	67,954	4,189,000	62	10,158	2	-
1877, .	49,700	2,562,000	51	6,956	2	-	1890, .	70,028	4,566,000	65	10,554	2	-
1878, .	50,736	2,260,000	45	7,058	2	-	1891, .	72,351	4,858,000	67	10,958	2	-
1879, .	51,702	2,442,000	47	7,183	2	-	1892, .	74,674	5,408,000	72	11,380	3	-
1880, .	52,669	2,426,000	46	7,322	2	-	1893, .	76,997	6,182,000	80	11,769	3	-
1881, .	54,067	2,460,000	45	7,523	2	-	1894, .	79,320	5,777,000	73	12,182	3	-
1882, .	55,465	2,515,000	45	7,724	2	-	1895, .	81,643	6,074,000	74	12,681	3	125.0
1883, .	56,863	2,668,000	47	8,004	2	-	1896, .	83,692	6,638,000	79	13,139	3	128.5
1884, .	58,261	2,670,000	46	8,338	2	-	1897, .	85,740	6,658,000	78	13,513	3	117.7
1885, .	59,658	3,074,000	52	8,731	2	-	1898, .	87,789	7,758,000	88	13,741	3	119.9
1886, .	61,732	3,458,000	56	9,091	2	-	1899, .	89,837	7,772,000	87	14,049	4	121.7
1887, .	63,806	3,861,000	61	9,413	2	-	1900, .	91,886	7,304,000	80	14,207	6	123.5

CANTON. (1889.)

1893, .	4,598	203,000	44	540	10	-	1897, .	4,615	164,000	35	739	17	19.8
1894, .	4,618	179,000	39	600	12	18.5	1898, .	4,605	180,000	39	770	17	20.0
1895, .	4,636	179,000	39	664	12	19.7	1899, .	4,594	208,000	45	814	32	20.5
1896, .	4,626	175,000	38	711	15	19.8	1900, .	4,584	209,000	46	836	40	21.7

COHASSET. (1886.)

1890, .	2,448	49,000	20	192	-	7.4	1896, .	2,531	79,000	32	287	-	7.6
1891, .	2,453	55,000	23	220	-	7.4	1897, .	2,588	66,000	25	294	-	8.2
1892, .	2,458	60,000	24	230	-	7.4	1898, .	2,645	74,000	28	306	-	8.2
1893, .	2,463	59,000	24	247	-	7.4	1899, .	2,702	127,000	47	365	-	9.5
1894, .	2,468	67,000	27	256	-	7.6	1900, .	2,759	129,000	47	376	-	9.5
1895, .	2,474	65,000	26	270	-	7.6							

COTTAGE CITY. (1890.)

1891, .	1,071	39,000	36	-	-	-	1896, .	1,050	72,000	68	488	-	12.9
1892, .	1,062	53,000	50	-	-	-	1897, .	1,063	94,000	89	537	-	13.4
1893, .	1,054	58,000	55	-	-	-	1898, .	1,075	103,000	96	576	-	13.5
1894, .	1,046	83,000	79	-	-	-	1899, .	1,088	124,000	114	560	-	13.8
1895, .	1,038	58,000	56	426	-	12.8	1900, .	1,100	151,000	137	598	-	14.0

DANVERS AND MIDDLETON. (1876.)

1877, .	7,308	357,000	49	515	-	25.5	1889, .	8,292	439,000	53	1,298	-	37.9
1878, .	7,404	280,000	38	625	-	25.8	1890, .	8,378	484,000	58	1,332	-	38.8
1879, .	7,500	324,000	43	696	-	28.0	1891, .	8,506	513,000	60	1,388	-	39.6
1880, .	7,598	353,000	47	790	-	28.5	1892, .	8,634	527,000	61	1,414	-	40.3
1881, .	7,670	396,000	52	881	-	31.0	1893, .	8,762	569,000	65	1,452	-	41.1
1882, .	7,742	410,000	53	940	-	31.5	1894, .	8,890	592,000	67	1,490	-	41.6
1883, .	7,814	463,000	59	1,008	-	31.7	1895, .	9,019	602,000	67	1,523	-	42.0
1884, .	7,886	411,000	52	1,062	-	32.5	1896, .	9,091	599,000	66	1,571	2	42.9
1885, .	7,960	440,000	55	1,096	-	32.5	1897, .	9,164	623,000	67	1,571	2	42.9
1886, .	8,044	420,000	52	1,148	-	33.3	1898, .	9,236	636,000	69	1,613	2	43.6
1887, .	8,124	429,000	53	1,212	-	36.4	1899, .	9,309	676,000	73	1,673	2	44.4
1888, .	8,208	472,000	57	1,262	-	37.5	1900, .	9,381	676,000	72	1,704	3	45.1

DEDHAM. (1881.)

Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1883, .	6,477	100,000	15	399	-	-	1892, .	7,159	278,000	39	915	-	-
1884, .	6,558	115,000	18	465	-	-	1893, .	7,177	308,000	43	947	-	-
1885, .	6,641	130,000	20	536	-	-	1894, .	7,195	371,000	52	980	2	-
1886, .	6,737	136,000	20	583	-	-	1895, .	7,211	419,000	58	1,040	2	-
1887, .	6,833	155,000	23	643	-	-	1896, .	7,260	500,000	69	1,106	2	21.7
1888, .	6,929	186,000	27	726	-	-	1897, .	7,309	500,000	69	1,205	2	-
1889, .	7,025	203,000	29	766	-	-	1898, .	7,359	513,000	70	1,310	2	-
1890, .	7,123	223,000	31	814	-	-	1899, .	7,408	604,000	82	1,355	2	-
1891, .	7,141	214,000	30	866	-	-	1900, .	7,457	586,000	79	1,354	2	24.0

EASTON. (1887.)

1889, .	4,384	87,000	20	268	-	-	1895, .	4,452	82,000	18	437	-	-
1890, .	4,493	93,000	21	304	-	-	1896, .	4,529	83,000	19	451	24	-
1891, .	4,484	85,000	19	346	-	-	1897, .	4,606	96,000	21	457	24	7.0
1892, .	4,476	99,000	22	380	-	-	1898, .	4,683	97,000	21	467	24	7.0
1893, .	4,468	92,000	20	400	-	-	1899, .	4,760	106,000	22	476	25	7.0
1894, .	4,460	88,000	20	428	-	-	1900, .	4,837	114,000	24	488	26	7.5

FAIRHAVEN. (1894.)

1895, .	3,338	70,000	21	310	14	14	1898, .	3,475	211,000	61	448	21	14
1896, .	3,384	110,000	32	370	18	14	1899, .	3,521	216,000	61	474	22	14
1897, .	3,430	172,000	50	424	20	14	1900, .	3,567	213,000	60	493	24	14

FALL RIVER. (1874.)

1875, .	45,340	811,000	18	1,146	17	39.8	1888, .	67,388	1,769,000	26	4,412	71	61.4
1876, .	46,064	1,058,000	23	1,660	35	46.1	1889, .	70,893	1,878,000	27	4,698	73	62.6
1877, .	46,788	1,174,000	25	2,060	43	48.4	1890, .	74,398	2,136,000	29	4,980	75	63.6
1878, .	47,512	1,204,000	25	2,324	50	51.7	1891, .	77,359	2,356,000	30	5,247	76	64.8
1879, .	48,236	1,264,000	26	2,497	55	52.0	1892, .	80,320	2,286,000	29	5,526	77	66.6
1880, .	48,961	1,354,000	28	2,684	59	52.0	1893, .	83,281	2,334,000	28	5,793	78	70.7
1881, .	50,543	1,488,000	29	2,905	61	52.9	1894, .	86,242	2,438,000	28	6,138	80	74.0
1882, .	52,125	1,831,000	35	3,120	63	54.2	1895, .	89,203	3,167,000	35	6,372	82	76.1
1883, .	53,707	1,640,000	30	3,370	65	55.5	1896, .	92,335	3,547,000	38	6,704	84	79.5
1884, .	55,289	1,426,000	26	3,611	67	56.6	1897, .	95,467	3,670,000	39	6,422	93	82.3
1885, .	56,870	1,488,000	26	3,818	67	57.8	1898, .	98,599	3,136,000	32	6,576	93	84.8
1886, .	60,376	1,603,000	27	3,986	68	58.8	1899, .	101,731	3,581,000	35	6,783	94	85.9
1887, .	63,882	1,591,000	25	4,197	70	59.7	1900, .	104,863	3,805,000	36	6,943	94	87.3

FALMOUTH. (1899.)

1900, .	3,500	136,000	39	302	2	16.5	-	-	-	-	-	-	-

FOXBOROUGH. (1891.)

1893, .	3,104	81,000	26	263	28	-	1897, .	3,238	150,000	46	437	40	13.2
1894, .	3,161	126,000	40	352	30	-	1898, .	3,247	151,000	47	445	42	13.3
1895, .	3,219	141,000	44	371	34	11.9	1899, .	3,257	195,000	60	453	45	13.3
1896, .	3,228	158,000	49	394	38	11.9	1900, .	3,266	176,000	54	458	46	13.3

FRAMINGHAM. (1885.)

YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1886, .	8,468	210,000	25	300	15	10.0	1894, .	9,459	321,000	34	960	21	18.0
1887, .	8,661	239,000	28	400	16	11.0	1895, .	9,512	362,000	38	1,000	21	18.2
1888, .	8,854	171,000	19	500	18	11.0	1896, .	9,870	376,000	39	1,040	23	18.5
1889, .	9,047	163,000	18	640	18	12.5	1897, .	10,228	322,000	31	1,067	27	20.0
1890, .	9,239	204,000	22	700	32	15.0	1898, .	10,586	344,000	33	1,130	34	22.2
1891, .	9,294	221,000	24	790	29	16.0	1899, .	10,944	416,000	38	1,185	38	23.5
1892, .	9,349	226,000	24	860	30	17.0	1900, .	11,302	433,000	38	1,230	46	23.7
1893, .	9,404	282,000	30	930	19	17.5							

FRANKLIN. (1884.)

1889, .	4,662	70,000	15	-	-	-	1895, .	5,136	201,000	39	-	-	-
1890, .	4,831	74,000	15	-	-	-	1896, .	5,112	214,000	42	-	-	-
1891, .	4,892	111,000	23	-	-	-	1897, .	5,088	173,000	34	-	-	-
1892, .	4,953	99,000	20	-	-	-	1898, .	5,065	144,000	28	-	-	-
1893, .	5,014	126,000	25	-	-	-	1899, .	5,041	167,000	33	-	-	-
1894, .	5,075	158,000	31	-	-	-	1900, .	5,017	173,000	34	550	22	-

GARDNER. (1882.)

1894, .	9,031	568,000	63	-	-	-	1898, .	10,161	729,000	72	1,050	-	25.0
1895, .	9,182	504,000	55	750	-	19.0	1899, .	10,487	698,000	67	1,150	-	27.5
1896, .	9,508	517,000	54	850	-	21.0	1900, .	10,813	726,000	67	1,250	4	30.0
1897, .	9,834	539,000	55	950	-	23.0							

GLOUCESTER. (1885.)

1891, .	25,363	491,000	19	-	-	-	1896, .	27,793	775,000	28	2,336	2	30.8
1892, .	26,075	551,000	21	-	-	-	1897, .	27,375	834,000	30	2,461	2	33.0
1893, .	26,787	829,000	31	-	-	-	1898, .	26,957	855,000	32	2,551	2	34.0
1894, .	27,499	773,000	28	-	-	-	1899, .	26,539	968,000	37	2,681	2	35.0
1895, .	28,211	739,000	26	2,120	2	28.0	1900, .	26,121	950,000	36	2,817	2	36.0

GROTON. (1897.)

1899, .	2,080	106,000	51	157	94	-	1900, .	2,052	69,000	34	175	97	9

HOLLISTON. (1891.)

1895, .	2,718	79,000	29	135	5	5.5	1898, .	2,646	-	-	-	-	-
1896, .	2,694	55,000	20	152	-	5.5	1899, .	2,622	-	-	-	-	-
1897, .	2,670	37,000	14	159	-	-	1900, .	2,598	38,000	15	121	-	6.0

Hyde Park. (1885.)

Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1894, .	11,499	459,000	40	1,712	-	28.7	1898, .	12,677	672,000	53	2,123	-	35.6
1895, .	11,826	483,000	41	1,806	-	31.8	1899, .	12,960	728,000	57	2,196	-	36.2
1896, .	12,110	636,000	52	1,910	-	32.8	1900, .	13,244	822,000	62	2,238	-	37.6
1897, .	12,480	579,000	47	2,025	-	35.1							

Ipswich. (1894.)

1896, .	4,708	74,000	16	509	9	12.5	1899, .	4,670	86,000	18	617	21	12.9
1897, .	4,695	88,000	19	541	16	12.5	1900, .	4,658	109,000	23	647	21	14.9
1898, .	4,683	71,000	15	583	19	12.9							

Lawrence. (1875.)

1877, .	36,610	1,554,000	42	2,443	4	36.6	1889, .	43,494	2,633,000	61	4,713	26	56.1
1878, .	37,457	1,250,000	33	2,764	5	39.0	1890, .	44,654	2,778,000	62	4,864	29	57.3
1879, .	38,304	1,456,000	38	3,011	7	40.7	1891, .	46,156	3,180,000	69	4,958	34	59.6
1880, .	39,151	1,861,000	48	3,224	8	42.2	1892, .	47,658	3,588,000	75	5,128	39	61.3
1881, .	39,094	1,838,000	47	3,459	10	43.9	1893, .	49,160	3,153,000	64	4,925	46	63.7
1882, .	39,036	1,951,000	50	3,653	12	45.3	1894, .	50,662	2,877,000	57	5,056	50	65.2
1883, .	38,976	2,163,000	56	3,896	13	48.3	1895, .	52,164	3,005,000	58	5,216	56	68.9
1884, .	38,920	2,147,000	55	4,059	15	49.7	1896, .	54,243	3,014,000	56	5,420	62	74.4
1885, .	38,862	2,296,000	59	4,215	16	51.8	1897, .	56,322	3,107,000	55	5,629	67	75.9
1886, .	40,020	2,573,000	64	4,356	18	52.7	1898, .	58,401	3,305,000	57	5,777	71	77.2
1887, .	41,178	2,515,000	61	4,477	21	53.6	1899, .	60,480	3,205,000	53	5,926	74	78.0
1888, .	42,336	2,670,000	63	4,586	23	55.1	1900, .	62,559	3,317,000	53	6,043	77	79.2

Longmeadow. (1895.)

1896, .	658	36,000	55	90	-	5.0	1899, .	772	60,000	77	154	-	7.3
1897, .	696	48,000	69	122	-	6.6	1900, .	811	67,000	83	157	-	-
1898, .	735	47,000	64	141	-	7.2							

Lowell. (1872.)

1875, .	49,688	1,222,000	25	3,754	3	47.1	1888, .	72,261	4,981,000	69	7,755	21	85.7
1876, .	51,645	1,485,000	29	4,095	4	51.8	1889, .	74,979	4,633,000	62	8,050	22	89.7
1877, .	53,602	1,631,000	30	4,423	5	54.9	1890, .	77,696	5,374,000	69	8,304	23	92.2
1878, .	55,559	1,785,000	32	4,714	8	57.5	1891, .	79,030	5,920,000	75	8,532	25	94.1
1879, .	57,516	2,023,000	35	5,075	12	60.7	1892, .	80,364	6,074,000	76	8,791	26	98.2
1880, .	59,475	2,252,000	38	5,498	13	63.0	1893, .	81,698	6,817,000	84	9,049	29	102.8
1881, .	60,401	2,399,000	40	5,878	15	68.1	1894, .	83,032	6,568,000	79	9,346	30	107.1
1882, .	61,327	2,623,000	43	6,283	17	70.6	1895, .	84,367	6,922,000	82	9,686	33	114.6
1883, .	62,253	2,863,000	46	6,653	19	73.8	1896, .	86,487	6,933,000	81	9,913	38	118.1
1884, .	63,179	3,016,000	48	6,953	19	77.2	1897, .	88,608	6,594,000	75	10,253	43	122.3
1885, .	64,107	3,563,000	56	6,997	20	79.3	1898, .	90,728	6,725,000	74	10,396	47	124.9
1886, .	66,825	3,958,000	59	7,127	20	81.3	1899, .	92,849	7,286,000	78	10,529	50	126.4
1887, .	69,543	4,319,000	62	7,440	21	83.0	1900, .	94,969	7,893,000	83	10,634	53	127.8

LYNN AND SAUGUS. (1871.)

YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1878, .	38,610	1,144,000	30	3,892	3	53.4	1890, .	59,400	2,657,000	45	9,490	4	101.6
1879, .	39,754	1,265,000	32	4,127	3	53.6	1891, .	60,890	3,131,000	51	10,010	4	109.4
1880, .	40,899	1,235,000	30	4,488	3	57.3	1892, .	62,380	3,549,000	57	10,588	5	115.9
1881, .	42,464	1,280,000	30	4,948	3	61.8	1893, .	63,870	3,744,000	59	11,095	6	120.2
1882, .	44,029	1,511,000	34	5,439	3	66.6	1894, .	65,360	4,020,000	62	11,442	8	121.7
1883, .	45,594	1,558,000	34	5,989	3	69.8	1895, .	66,851	4,360,000	65	11,698	10	124.8
1884, .	47,159	1,739,000	37	6,505	3	74.6	1896, .	68,200	4,539,000	66	11,965	13	125.8
1885, .	48,722	1,921,000	39	6,919	3	79.1	1897, .	69,549	4,642,000	66	12,179	15	126.0
1886, .	50,858	2,116,000	42	7,374	3	79.8	1898, .	70,899	4,746,000	67	12,298	17	127.5
1887, .	52,994	2,379,000	45	7,805	3	90.3	1899, .	72,247	5,379,000	74	12,447	19	128.5
1888, .	55,130	2,475,000	45	8,325	3	92.0	1900, .	73,597	4,680,000	64	12,569	20	129.0
1889, .	57,266	2,450,000	43	8,882	4	96.7							

MANCHESTER. (1892.)

1894, .	1,857	110,000	59	442	1	15.3	1898, .	2,264	167,000	74	559	1	18.2
1895, .	1,876	116,000	62	485	1	16.3	1899, .	2,393	211,000	88	595	1	19.7
1896, .	2,005	153,000	76	532	1	17.4	1900, .	2,522	217,000	86	654	2	20.3
1897, .	2,134	149,000	70	538	1	17.0							

MANSFIELD.* (1888.)

1890, .	3,432	145,000	42	248	27	7.3	1896, .	3,779	127,000	34	521	28	15.3
1891, .	3,490	166,000	46	286	28	7.7	1897, .	3,836	110,000	29	553	29	15.4
1892, .	3,548	172,000	48	321	29	7.9	1898, .	3,892	135,000	35	591	29	15.7
1893, .	3,606	209,000	58	349	29	8.0	1899, .	3,949	139,000	35	642	31	16.2
1894, .	3,664	222,000	60	373	29	8.0	1900, .	4,006	133,000	33	635	-	-
1895, .	3,722	125,000	34	476	27	15.3							

MARBLEHEAD. (1885.)

1891, .	8,095	156,000	19	817	-	25.1	1896, .	7,653	277,000	36	1,371	-	28.7
1892, .	7,989	203,000	25	951	-	25.5	1897, .	7,635	321,000	42	1,372	-	28.7
1893, .	7,883	206,000	26	1,019	-	25.5	1898, .	7,618	414,000	54	1,511	-	28.7
1894, .	7,777	205,000	26	1,177	-	26.5	1899, .	7,600	456,000	60	1,591	-	29.4
1895, .	7,671	268,000	35	1,290	-	28.5	1900, .	7,582	506,000	67	1,653	-	30.7

MARLBOROUGH. (1883.)

1884, .	10,778	137,000	13	795	6	15.3	1893, .	14,507	440,000	30	2,080	27	32.8
1885, .	10,941	190,000	17	963	7	17.6	1894, .	14,741	530,000	35	2,151	32	33.5
1886, .	11,514	235,000	20	1,182	7	19.8	1895, .	14,977	510,000	34	2,209	38	35.9
1887, .	12,087	259,000	21	1,351	7	21.5	1896, .	14,703	548,000	37	2,265	41	37.0
1888, .	12,660	300,000	24	1,476	8	23.6	1897, .	14,430	535,000	37	2,234	45	37.2
1889, .	13,233	317,000	24	1,627	9	24.5	1898, .	14,156	537,000	38	2,261	47	37.2
1890, .	13,805	348,000	25	1,794	11	27.0	1899, .	13,883	525,000	38	2,253	48	37.2
1891, .	14,039	364,000	26	1,897	12	29.0	1900, .	13,609	493,000	36	2,244	51	37.2
1892, .	14,273	425,000	30	1,973	24	32.0							

MAYNARD. (1889.)

1895, .	3,090	78,000	25	433	-	8.5	1898, .	3,121	117,000	37	473	10	9.4
1896, .	3,100	72,000	23	443	-	13.5	1899, .	3,132	113,000	36	484	13	9.5
1897, .	3,111	84,000	27	443	9	8.5	1900, .	3,142	106,000	34	490	14	9.5

* The supply to the N. Y., N. H. & H. R.R. was discontinued at the end of 1894.

Methuen. (1875.)

Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1895, .	5,690	149,000	26	570	61	-	1898, .	6,783	230,000	34	875	63	25.8
1896, .	6,054	170,000	28	695	68	21.5	1899, .	7,148	250,000	35	972	65	26.0
1897, .	6,419	216,000	34	795	69	25.0	1900, .	7,512	298,000	40	1,060	67	27.4

Middleborough. (1885.)

1886, .	5,343	47,000	9	279	21	9.1	1894, .	6,564	214,000	33	673	35	13.5
1887, .	5,523	73,000	13	375	21	9.6	1895, .	6,689	212,000	32	697	37	14.0
1888, .	5,703	88,000	15	412	22	9.9	1896, .	6,728	211,000	31	725	38	15.4
1889, .	5,884	99,000	17	467	22	10.5	1897, .	6,767	196,000	29	751	39	16.0
1890, .	6,065	129,000	21	519	24	11.2	1898, .	6,807	214,000	31	773	40	16.2
1891, .	6,190	149,000	24	568	26	11.7	1899, .	6,846	224,000	33	799	42	16.2
1892, .	6,315	163,000	26	617	29	12.1	1900, .	6,885	233,000	34	828	42	17.0
1893, .	6,439	197,000	31	646	33	12.9							

Milford and Hopedale. (1881.)

1895, .	10,336	527,000	51	1,183	13	35	1898, .	12,212	559,000	46	1,383	12	-
1896, .	10,961	640,000	58	1,276	13	30	1899, .	12,838	668,000	52	1,442	12	-
1897, .	11,587	606,000	52	1,333	13	-	1900, .	13,463	851,000	63	1,575	12	42

Millbury. (1895.)

1898, .	4,765	77,000	16	-	-	-	1900, .	4,460	133,000	30	-	-	-
1899, .	4,612	117,000	25	-	-	-							

Milton. (1885.)

1894, .	4,856	129,000	27	438	100	-	1898, .	6,154	161,000	26	702	100	-
1895, .	5,518	133,000	24	512	100	-	1899, .	6,366	148,000	23	795	100	-
1896, .	5,730	150,000	26	560	100	-	1900, .	6,578	207,000	31	852	100	32.9
1897, .	5,942	134,000	22	624	100	-							

Montague. (1887.)

1889, .	6,163	253,000	41	247	-	-	1895, .	6,058	320,000	53	382	2	10.0
1890, .	6,296	283,000	45	289	-	-	1896, .	6,076	382,000	63	388	1	-
1891, .	6,250	291,000	47	307	-	-	1897, .	6,095	415,000	68	414	3	11.4
1892, .	6,202	357,000	58	334	-	-	1898, .	6,113	412,000	67	431	3	12.0
1893, .	6,154	329,000	54	352	1	-	1899, .	6,132	430,000	70	439	2	12.0
1894, .	6,106	334,000	55	371	1	-	1900, .	6,150	446,000	73	447	2	12.0

Nantucket. (1878.)

1884, .	3,259	30,000	9	-	-	-	1893, .	3,116	86,000	27	688	-	-
1885, .	3,142	38,000	12	-	-	-	1894, .	3,066	81,000	26	722	-	-
1886, .	3,167	40,000	13	-	-	-	1895, .	3,016	89,000	30	750	-	-
1887, .	3,192	50,000	16	-	-	-	1896, .	3,014	84,000	28	776	-	-
1888, .	3,217	59,000	18	-	-	-	1897, .	3,012	83,000	27	820	-	-
1889, .	3,242	54,000	17	-	-	-	1898, .	3,010	87,000	29	850	-	-
1890, .	3,268	70,000	22	-	-	-	1899, .	3,008	113,000	37	897	-	-
1891, .	3,216	65,000	20	616	-	-	1900, .	3,006	125,000	42	929	-	12.7
1892, .	3,166	79,000	25	643	-	-							

NATICK. (1874.)

YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1875, .	7,419	187,000	25	–	–	–	1888, .	8,856	280,000	32	1,349	–	–
1876, .	7,631	172,000	23	366	2	–	1889, .	8,988	247,000	27	1,349	–	–
1877, .	7,842	173,000	22	566	2	–	1890, .	9,118	264,000	29	1,388	3	28.3
1878, .	8,054	250,000	31	686	–	–	1891, .	9,058	307,000	34	1,426	3	28.6
1879, .	8,266	252,000	30	744	–	–	1892, .	8,997	336,000	37	1,454	4	29.3
1880, .	8,479	227,000	27	795	–	–	1893, .	8,936	355,000	40	1,486	–	29.8
1881, .	8,475	198,000	23	843	–	–	1894, .	8,874	368,000	41	1,505	–	29.6
1882, .	8,471	248,000	29	884	2	–	1895, .	8,814	376,000	43	1,577	–	31.5
1883, .	8,467	279,000	33	927	3	–	1896, .	8,949	408,000	46	1,621	12	32.8
1884, .	8,463	233,000	28	985	–	–	1897, .	9,084	375,000	41	1,689	15	34.7
1885, .	8,460	225,000	27	1,061	–	–	1898, .	9,218	369,000	40	1,730	21	38.0
1886, .	8,592	277,000	32	1,141	–	–	1899, .	9,353	395,000	42	1,789	27	38.1
1887, .	8,724	266,000	30	1,259	–	–	1900, .	9,488	378,000	40	1,828	39	38.7

NEEDHAM. (1890.)

1892, .	3,225	65,000	20	362	36	17.0	1897, .	3,713	183,000	50	633	97	23.8
1893, .	3,320	106,000	32	443	42	20.8	1898, .	3,814	212,000	56	664	98	26.6
1894, .	3,415	112,000	33	493	45	22.1	1899, .	3,915	224,000	58	688	99	26.9
1895, .	3,511	139,000	40	534	48	22.6	1900, .	4,016	224,000	56	706	99	26.9
1896, .	3,612	146,000	41	595	98	23.8							

NEW BEDFORD. (1869.)

1875, .	25,895	1,137,000	44	2,369	0.5	35.8	1888, .	37,797	3,360,000	89	5,785	2.0	59.2
1876, .	26,085	1,520,000	58	2,659	0.3	35.6	1889, .	39,265	3,590,000	91	6,104	2.0	61.1
1877, .	26,275	1,684,000	64	2,944	0.3	37.4	1890, .	40,733	4,066,000	100	6,394	2.0	62.5
1878, .	26,465	1,860,000	70	3,279	0.4	38.5	1891, .	43,636	4,146,000	95	6,742	2.0	64.9
1879, .	26,655	2,039,000	77	3,445	0.5	40.4	1892, .	46,539	4,393,000	94	7,134	2.0	68.6
1880, .	26,845	2,043,000	76	3,798	1.0	42.7	1893, .	49,443	4,998,000	101	7,531	2.0	72.2
1881, .	28,155	2,313,000	82	3,985	1.0	43.3	1894, .	52,347	4,787,000	91	7,767	3.0	74.6
1882, .	29,465	2,326,000	80	4,203	1.0	44.2	1895, .	55,251	4,712,000	85	8,027	3.0	76.5
1883, .	30,775	2,326,000	76	4,465	1.0	46.4	1896, .	56,689	5,259,000	93	8,447	4.0	83.9
1884, .	32,085	2,371,000	74	4,691	1.0	48.6	1897, .	58,127	5,676,000	98	8,860	7.0	87.5
1885, .	33,393	2,876,000	86	4,965	1.0	50.3	1898, .	59,566	5,908,000	99	9,014	8.0	89.3
1886, .	34,861	2,977,000	85	5,225	2.0	52.7	1899, .	61,004	6,195,000	101	9,151	12.5	90.6
1887, .	36,329	3,047,000	84	5,495	2.0	54.4	1900, .	62,442	6,321,000	101	9,280	15.0	92.7

NEWBURYPORT. (1881.)

1886, .	13,762	272,000	20	–	–	–	1894, .	14,431	621,000	43	–	–	–
1887, .	13,808	254,000	18	–	–	–	1895, .	14,552	667,000	46	2,356	–	31.0
1888, .	13,854	316,000	23	–	–	–	1896, .	14,537	613,000	42	2,455	1	31.0
1889, .	13,901	388,000	28	–	–	–	1897, .	14,522	549,000	38	2,523	2	31.0
1890, .	13,947	426,000	31	–	–	–	1898, .	14,508	518,000	36	2,581	2	31.0
1891, .	14,068	423,000	30	–	–	–	1899, .	14,493	589,000	40	2,694	2	31.0
1892, .	14,189	506,000	36	–	–	–	1900, .	14,478	617,000	43	2,802	2	32.5
1893, .	14,310	564,000	39	–	–	–							

NEWTON. (1876.)

1878, .	16,639	328,000	20	1,685	17	–	1882, .	18,101	595,000	33	2,581	26	–
1879, .	16,817	375,000	22	1,917	19	–	1883, .	18,654	624,000	34	2,740	28	–
1880, .	16,995	452,000	27	1,937	22	–	1884, .	19,207	533,000	28	2,919	30	–
1881, .	17,548	451,000	25	2,412	22	–	1885, .	19,759	615,000	31	3,134	32	–

NEWTON (1876) — *Concluded.*

Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1886, .	20,683	675,000	33	3,432	46	77.0	1894, .	26,947	1,623,000	60	5,586	76	113.5
1887, .	21,607	704,000	33	3,767	63	83.0	1895, .	27,590	1,801,000	65	5,917	77	120.0
1888, .	22,531	703,000	31	3,978	63	87.0	1896, .	28,789	1,812,000	63	6,276	79	125.7
1889, .	23,455	853,000	36	4,203	64	90.2	1897, .	29,990	1,804,000	60	6,573	79	130.8
1890, .	24,379	985,000	40	4,440	70	93.6	1898, .	31,189	1,758,000	57	6,771	81	133.6
1891, .	25,021	1,067,000	42	4,705	70	102.0	1899, .	32,389	2,036,000	63	6,945	83	135.4
1892, .	25,663	1,288,000	50	5,002	72	105.0	1900, .	33,587	2,086,000	62	7,087	85	136.6
1893, .	26,305	1,370,000	52	5,281	74	109.7							

NORTH ANDOVER. (1898.)

1899, .	4,108	53,000	13	290	38	15.2	1900, .	4,243	78,000	18	373	53	15.6

NORTH ATTLEBOROUGH. (1884.)

1895, .	6,576	183,000	28	811	93	14.3	1898, .	6,982	191,000	27	806	100	14.6
1896, .	6,711	186,000	28	828	94	14.4	1899, .	7,118	243,000	34	832	100	14.6
1897, .	6,847	164,000	24	791	100	14.6	1900, .	7,253	262,000	36	846	100	14.6

NORTH BROOKFIELD. (1893.)

1895, .	4,635	92,000	20	349	1	-	1898, .	4,606	155,000	34	420	1	9.0
1896, .	4,625	132,000	29	372	1	8.3	1899, .	4,597	185,000	40	445	-	10.0
1897, .	4,616	166,000	36	402	1	8.6	1900, .	4,587	218,000	48	449	-	10.1

NORWOOD. (1885.)

1888, .	3,407	150,000	44	371	23	8.3	1895, .	4,574	270,000	59	741	29	13.0
1889, .	3,569	160,000	45	430	22	9.5	1896, .	4,753	309,000	65	794	33	16.1
1890, .	3,733	169,000	45	478	24	10.4	1897, .	4,936	354,000	72	868	36	15.6
1891, .	3,901	178,000	46	528	24	10.6	1898, .	5,118	405,000	79	925	38	15.9
1892, .	4,069	169,000	42	559	19	10.9	1899, .	5,299	424,000	80	991	41	16.3
1893, .	4,237	208,000	49	608	25	11.8	1900, .	5,480	400,000	73	1,045	44	17.0
1894, .	4,405	220,000	50	654	26	11.9							

ORANGE. (1873.)

1894, .	5,202	118,000	23	-	-	-	1898, .	5,456	-	-	496	43	11.0
1895, .	5,361	138,000	26	348	33	11.0	1899, .	5,488	160,000	29	541	46	11.0
1896, .	5,393	150,000	28	418	36	11.0	1900, .	5,520	158,000	29	592	51	11.2
1897, .	5,425	138,000	25	470	39	11.0							

PEABODY. (1799.)

1883, .	9,330	566,000	61	944	-	21.5	1892, .	10,298	782,000	76	1,585	-	29.0
1884, .	9,430	540,000	57	1,002	-	22.0	1893, .	10,368	760,000	73	1,648	-	30.0
1885, .	9,530	616,000	65	1,178	-	23.0	1894, .	10,438	785,000	75	1,710	-	30.5
1886, .	9,656	576,000	60	1,234	-	24.0	1895, .	10,507	900,000	86	1,780	-	31.8
1887, .	9,782	668,000	68	1,269	-	25.2	1896, .	10,710	927,000	87	1,845	-	34.0
1888, .	9,908	685,000	69	1,329	-	26.0	1897, .	10,913	935,000	86	1,928	-	35.2
1889, .	10,034	746,000	74	1,399	-	26.0	1898, .	11,117	967,000	87	1,994	-	37.0
1890, .	10,158	827,000	81	1,449	-	27.0	1899, .	11,320	1,140,000	100	2,056	-	38.5
1891, .	10,228	823,000	80	1,507	-	28.8	1900, .	11,523	1,036,000	90	2,104	28	38.9

PROVINCETOWN. (1893.)

YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1895, .	4,555	66,000	14	449	8	8.5	1898, .	4,370	126,000	29	524	10	8.8
1896, .	4,493	91,000	20	486	9	8.7	1899, .	4,309	172,000	38	539	10	8.8
1897, .	4,432	125,000	28	508	9	8.8	1900, .	4,247	191,000	45	558	9	8.8

RANDOLPH AND HOLBROOK. (1888.)

1889, .	6,364	148,000	23	–	–	–	1895, .	5,992	273,000	45	–	–	–
1890, .	6,420	192,000	30	–	–	–	1896, .	6,038	287,000	48	–	–	–
1891, .	6,336	274,000	43	–	–	–	1897, .	6,084	279,000	46	–	–	–
1892, .	6,250	254,000	41	–	–	–	1898, .	6,130	284,000	46	–	–	–
1893, .	6,164	290,000	47	–	–	–	1899, .	6,176	292,000	47	–	–	–
1894, .	6,078	263,000	43	–	–	–	1900, .	6,222	233,000	37	–	–	–

READING.* (1891.)

1892, .	4,340	165,000	38	503	3	–	1897, .	4,818	143,000	30	887	21	23.1
1893, .	4,466	222,000	50	600	4	18.0	1898, .	4,868	113,000	23	928	92	23.6
1894, .	4,592	224,000	49	684	6	20.0	1899, .	4,919	131,000	27	1,018	90	24.6
1895, .	4,717	198,000	42	753	12	20.4	1900, .	4,969	149,000	30	1,058	91	26.9
1896, .	4,767	199,000	42	812	17	20.4							

ROCKPORT. (1895.)

1896, .	5,150	172,000	33	655	2	–	1899, .	4,731	191,000	40	769	2	–
1897, .	5,010	170,000	34	689	2	–	1900, .	4,592	240,000	52	793	2	–
1898, .	4,871	133,000	27	713	2	13							

RUTLAND. (1896.)

1897, .	1,120	16,000	14	50	–	2	1899, .	1,263	45,000	36	55	–	3
1898, .	1,192	19,000	16	38	–	2	1900, .	1,334	70,000	52	66	–	4

SALEM. (1868.)

1887, .	29,174	2,178,000	75	5,255	2	–	1894, .	33,737	2,280,000	68	6,059	3	–
1888, .	29,716	2,112,000	71	5,362	2	–	1895, .	34,473	2,163,000	63	6,173	2	–
1889, .	30,268	2,072,000	68	5,496	2	–	1896, .	34,770	2,297,000	66	6,298	2	–
1890, .	30,801	2,184,000	71	5,579	2	–	1897, .	35,066	2,231,000	64	6,415	3	66.1
1891, .	31,535	2,511,000	80	5,685	2	–	1898, .	35,363	2,298,000	65	6,494	2	66.6
1892, .	32,269	2,579,000	80	5,802	2	–	1899, .	35,659	2,502,000	70	6,549	2	67.0
1893, .	33,003	2,120,000	64	5,931	3	–	1900, .	35,956	2,712,000	75	6,608	3	67.2

SHARON. (1885.)

1891, .	1,651	30,000	18	159	–	–	1896, .	1,786	42,000	23	237	–	8.4
1892, .	1,668	27,000	16	173	–	–	1897, .	1,854	40,000	22	256	1	8.4
1893, .	1,685	34,000	20	184	–	–	1898, .	1,923	47,000	24	266	1	8.8
1894, .	1,701	39,000	23	201	–	6.7	1899, .	1,991	64,000	32	283	1	9.3
1895, .	1,717	36,000	21	218	–	7.9	1900, .	2,060	72,000	35	293	1	9.4

* The water supply of Reading contained an excessive quantity of iron until a filter was installed in July, 1896; since that time the water has contained only small quantities of iron but is very hard.

Stoughton.* (1886.)

Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1895, .	5,272	246,000	47	400	26	16.2	1898, .	5,374	260,000	48	487	64	16.2
1896, .	5,306	247,000	46	422	57	16.2	1899, .	5,408	252,000	47	527	61	16.2
1897, .	5,340	211,000	40	455	64	16.2	1900, .	5,442	155,000	28	563	59	16.2

Taunton. (1876.)

Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1877, .	20,753	357,000	17	-	-	-	1889, .	25,094	770,000	31	3,143	30	59.3
1878, .	20,907	346,000	17	-	-	-	1890, .	25,448	807,000	32	3,253	30	61.3
1879, .	21,061	400,000	19	1,355	13	-	1891, .	25,781	1,035,000	40	3,386	31	66.1
1880, .	21,213	515,000	24	1,608	16	-	1892, .	26,114	1,012,000	39	3,507	32	67.8
1881, .	21,705	566,000	26	1,813	18	-	1893, .	26,447	1,066,000	40	3,635	34	69.0
1882, .	22,197	590,000	27	2,062	19	-	1894, .	26,781	1,098,000	41	3,751	35	70.5
1883, .	22,689	611,000	27	2,289	20	47.3	1895, .	27,115	1,153,000	43	3,843	36	70.7
1884, .	23,181	606,000	26	2,422	22	-	1896, .	27,899	1,179,000	42	3,955	36	71.6
1885, .	23,674	668,000	28	2,523	24	-	1897, .	28,683	1,250,000	44	4,090	38	73.7
1886, .	24,029	783,000	33	2,727	25	52.9	1898, .	29,468	1,302,000	44	4,233	38	75.9
1887, .	24,384	725,000	30	2,875	27	54.6	1899, .	30,252	1,458,000	48	4,372	40	77.1
1888, .	24,739	752,000	30	3,027	28	55.9	1900, .	31,036	1,645,000	53	4,502	41	78.3

Tisbury. (1887.)

Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1895, .	1,002	23,000	23	-	-	-	1898, .	1,090	46,000	42	281	1	8.0
1896, .	1,031	24,000	23	270	1	7.5	1899, .	1,120	60,000	54	290	1	8.0
1897, .	1,061	30,000	28	272	1	8.0	1900, .	1,149	57,000	50	300	1	8.0

Wakefield and Stoneham. (1883.)

Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1885, .	11,719	347,000	30	-	-	-	1893, .	14,007	553,000	39	-	-	-
1886, .	12,003	363,000	30	-	-	-	1894, .	14,297	580,000	41	-	-	-
1887, .	12,287	322,000	26	-	-	-	1895, .	14,588	612,000	42	-	-	-
1888, .	12,571	390,000	31	-	-	-	1896, .	14,768	688,000	47	-	-	-
1889, .	12,853	467,000	36	-	-	-	1897, .	14,948	666,000	45	-	-	-
1890, .	13,137	537,000	41	-	-	-	1898, .	15,127	774,000	51	-	-	-
1891, .	13,427	541,000	40	-	-	-	1899, .	15,307	949,000	62	-	-	-
1892, .	13,717	598,000	44	-	-	-	1900, .	15,487	1,091,000	70	2,788	2	-

Walpole. (1896.)

Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1897, .	3,225	58,000	18	341	27	15.5	1899, .	3,456	146,000	42	423	30	16.4
1898, .	3,341	89,000	27	386	29	16.4	1900, .	3,572	160,000	45	454	33	16.5

Waltham. (1873.)

Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	Year.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1875, .	9,967	495,000	50	-	-	-	1888, .	17,069	533,000	31	2,197	1	36.4
1876, .	10,316	355,000	34	729	-	18.0	1889, .	17,889	569,000	32	2,339	1	37.7
1877, .	10,665	348,000	33	857	13	20.5	1890, .	18,707	626,000	33	2,489	2	38.9
1878, .	11,014	329,000	30	938	11	21.6	1891, .	19,141	769,000	40	2,650	2	41.9
1879, .	11,363	344,000	30	1,035	-	22.3	1892, .	19,575	919,000	47	2,820	2	44.4
1880, .	11,712	410,000	35	1,135	-	-	1893, .	20,009	1,055,000	53	2,920	3	45.9
1881, .	12,291	449,000	37	1,295	-	-	1894, .	20,443	1,239,000	61	2,990	3	47.1
1882, .	12,870	523,000	41	1,421	-	-	1895, .	20,876	1,222,000	59	3,035	2	47.8
1883, .	13,449	602,000	45	1,559	-	27.9	1896, .	21,397	1,520,000	71	3,085	2	48.1
1884, .	14,029	519,000	37	1,694	-	29.0	1897, .	21,918	1,541,000	70	3,130	2	49.0
1885, .	14,609	529,000	36	1,802	1	30.0	1898, .	22,439	1,699,000	76	3,192	2	50.0
1886, .	15,429	608,000	39	1,884	1	32.7	1899, .	22,960	2,027,000	88	3,225	2	50.0
1887, .	16,249	544,000	33	2,042	1	34.3	1900, .	23,481	2,118,000	90	3,285	2	51.0

* The great reduction in consumption of water in Stoughton in 1900 is due in part to the discovery and prevention of leakage from the main pipes.

WARE. (1886.)

YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1888, .	6,799	130,000	19	-	-	-	1895, .	7,651	241,000	31	677	66	-
1889, .	7,064	170,000	24	381	47	8.2	1896, .	7,773	232,000	30	703	79	10.9
1890, .	7,329	160,000	22	430	49	8.4	1897, .	7,896	237,000	30	719	94	10.9
1891, .	7,393	195,000	26	490	50	8.6	1898, .	8,018	262,000	33	731	95	10.9
1892, .	7,457	186,000	25	572	51	-	1899, .	8,141	282,000	35	763	94	11.1
1893, .	7,521	215,000	29	610	56	-	1900, .	8,263	286,000	35	774	95	11.3
1894, .	7,586	206,000	27	642	59	-							

WAREHAM. (1894.)

1896, .	3,380	12,000	4	204	-	5.7	1899, .	3,419	20,000	6	340	-	7.5
1897, .	3,393	13,000	4	262	-	6.0	1900, .	3,432	24,000	7	375	-	8.2
1898, .	3,406	19,000	6	300	-	6.5							

WEBSTER. (1881.)

1895, .	7,799	209,000	27	530	27	-	1898, .	8,402	304,000	36	665	33	11.0
1896, .	8,000	233,000	29	560	33	10.0	1899, .	8,603	299,000	35	701	37	11.3
1897, .	8,201	275,000	34	604	33	10.7	1900, .	8,804	373,000	42	744	40	11.7

WELLESLEY. (1884.)

1886, .	3,130	89,000	29	245	15	-	1894, .	4,104	186,000	45	647	91	24.9
1887, .	3,247	101,000	31	302	16	17.6	1895, .	4,229	175,000	41	685	96	26.2
1888, .	3,364	132,000	39	412	16	19.7	1896, .	4,398	193,000	44	729	95	27.8
1889, .	3,481	195,000	56	465	18	20.7	1897, .	4,566	177,000	39	766	94	28.0
1890, .	3,600	255,000	71	503	18	22.1	1898, .	4,735	167,000	35	795	93	28.4
1891, .	3,726	253,000	68	546	20	23.6	1899, .	4,903	212,000	44	836	92	29.0
1892, .	3,852	239,000	62	584	28	23.8	1900, .	5,072	239,000	47	878	90	30.5
1893, .	3,978	201,000	50	610	93	24.2							

WESTON. (1896.)

1897, .	1,760	29,000	16	59	100	6.5	1899, .	1,809	55,000	30	107	100	9.2
1898, .	1,784	*23,000	16	76	100	8.5	1900, .	1,834	52,000	28	128	100	10.0

WHITMAN. (1883.)

1889, .	4,271	101,000	24	445	32	10.4	1895, .	5,744	188,000	33	843	44	15.2
1890, .	4,441	87,000	20	528	32	11.7	1896, .	5,826	231,000	40	883	45	16.3
1891, .	4,702	123,000	26	612	36	12.0	1897, .	5,908	168,000	28	903	46	16.4
1892, .	4,963	158,000	32	664	41	12.7	1898, .	5,991	139,000	23	925	46	16.5
1893, .	5,224	189,000	36	757	43	14.4	1899, .	6,073	162,000	27	965	47	16.7
1894, .	5,485	196,000	36	802	44	14.5	1900, .	6,155	133,000	22	988	47	17.1

WINCHENDON. (1896.)

1897, .	4,694	48,000	10	218	96	13.1	1899, .	4,899	62,000	13	330	89	13.5
1898, .	4,797	57,000	12	268	93	13.3	1900, .	5,001	56,000	11	387	96	13.9

* Ten months.

WOBURN.* (1873.)

YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1875, .	9,568	708,000	74	835	–	–	1888, .	12,800	769,000	60	1,989	2	–
1876, .	9,841	713,000	72	992	–	–	1889, .	13,150	674,000	51	2,091	2	43.5
1877, .	10,114	518,000	51	–	–	–	1890, .	13,499	777,000	58	2,156	2	45.6
1878, .	10,387	600,000	58	1,084	2	32.9	1891, .	13,635	730,000	54	2,170	1	47.2
1879, .	10,660	733,000	69	1,208	2	33.0	1892, .	13,771	775,000	56	2,280	2	49.0
1880, .	10,931	749,000	69	–	–	–	1893, .	13,907	900,000	65	2,370	1	49.2
1881, .	11,095	770,000	69	–	–	36.3	1894, .	14,043	972,000	69	2,388	2	50.2
1882, .	11,259	815,000	72	–	–	–	1895, .	14,178	1,039,000	73	2,453	2	50.9
1883, .	11,423	726,000	64	1,559	2	–	1896, .	14,193	1,026,000	72	2,510	3	51.3
1884, .	11,587	610,000	53	1,617	2	–	1897, .	14,208	968,000	68	2,773	2	–
1885, .	11,750	693,000	59	1,697	2	–	1898, .	14,224	995,000	70	2,821	2	–
1886, .	12,100	870,000	72	1,773	2	–	1899, .	14,239	1,110,000	78	2,869	2	53.3
1887, .	12,450	889,000	71	1,904	2	–	1900, .	14,254	1,116,000	78	2,894	2	53.9

WORCESTER. (1845.)

YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).	YEAR.	Population.	Average Daily Consumption (Gallons).	Daily Consumption per Person (Gallons).	Number of Services.	Per Cent. Metered Services.	Length of Distributing Pipe (Miles).
1896, .	102,698	6,126,000	60	11,947	93	147.5	1899, .	114,490	7,632,000	67	13,008	95	170.2
1897, .	106,629	–	–	12,330	93	156.0	1900, .	118,421	8,153,000	69	13,292	94	173.5
1898, .	110,559	6,785,000	61	12,672	94	164.4							

* The excessive consumption of water in the first years of the works was due, in part, to leakage from the distributing reservoir.

The foregoing table gives the total quantity of water pumped, and probably includes, beside the water used for domestic purposes, a considerable quantity lost by leakage from the pipes in the streets or from the distributing reservoir. What this quantity may be cannot be accurately ascertained, but it will be indicated in a subsequent table. In certain cities and towns a considerable quantity of water is used in manufacturing processes or for mechanical purposes. A large quantity of water is also used in public drinking fountains where the water is allowed to run continuously, and for watering streets and flushing sewers. In a few municipalities records are kept of the amount of water used for these purposes. After deducting the water used for these various purposes the remaining water is chiefly used for strictly domestic purposes, or is lost by leakage from the plumbing fixtures in houses. The quantity of water lost by leakage is, in some places, very great, and at times of cold weather, when faucets are left open to keep the pipes from freezing, this amount is very much increased. In these tables no attempt has been made to separate the water used for strictly domestic purposes, but the total amount of water pumped has been taken to be the consumption of water by the city or town.

The unit ordinarily adopted is the consumption of water per person per day. In order to ascertain the consumption per person it is necessary to know the number of people using the water, but usually this information cannot be obtained. In a few places records are kept from which an estimate of the actual number of persons using the water can be made, but as these estimates would not be accurate and can only be obtained for a small proportion of the cities and towns, the total population of the city or town has been used in obtaining the consumption per person. In some towns whole villages are not provided with the public water supply, and in some towns, especially where works have been recently introduced, large numbers of people have not availed themselves of the public water supply; but with the exception of those places where works have been very recently introduced the difference between the population actually supplied with water and the total population of the town is in most cases small.

An estimate of the population supplied from the different water works, based on the number of service pipes in use, would be very misleading if applied to the cities and towns of Massachusetts. This is shown in the following tables, the first of which gives the average number of people to each service in a few of those cities and towns where it is known that the public water supply is used by practically the entire population. The second table gives the population per service in those towns where water works have been recently introduced and it is known that a comparatively small proportion of the total population of the town uses the public water supply.

Population per Service in Cities where the Public Water Supply is available to practically the Entire Population.

City.	Population (1900).	Number of Services.	Population per Service.	City.	Population (1900).	Number of Services.	Population per Service.
Fall River, . .	104,863	6,943	15	Lynn and Saugus,.	73,597	12,569	6
Lawrence, . .	62,559	6,043	10	Marlborough, .	13,609	2,244	6
Lowell, . . .	94,969	10,634	9	Salem, . . .	35,956	6,608	5
Worcester, . .	118,421	13,292	9	Woburn, . .	14,254	2,894	5
Waltham, . .	23,481	3,285	7	Newburyport, .	14,478	2,802	5
New Bedford, .	62,442	9,280	7	Newton, . . .	33,587	7,087	5
Cambridge, . .	91,886	14,207	6				

Population per Service in Towns where the Water Supply has recently been introduced and a comparatively Small Proportion of the Population is supplied with Water from the Public Works.

Town.	Population (1900).	Number of Services.	Population per Service.	Town.	Population (1900).	Number of Services.	Population per Service.
North Andover, .	4,243	373	11	Billerica, . .	2,775	209	13
Falmouth, . .	3,500	302	12	Winchendon, .	5,001	387	13
Groton, . . .	2,052	175	12	Weston, . .	1,834	128	14

It will be seen from the above tables that in the thickly built up cities, where the public water supply is available to nearly every family in the city, the population per service varies greatly, owing to the fact that in such cities as Fall River and Lawrence a large number of families are in many cases supplied with water in tenement houses through a single service pipe. On the other hand, in cities like Newton, where the public supply is also available to nearly every inhabitant, the population per service is very much less, as the majority of services supply only one family. In the towns included in the second table, where water has been but recently introduced and comparatively few families are supplied with water, the population per service is no greater than in the city of Fall River.

There is a great variation in the consumption of water in the different cities and towns, due in a large measure to the different uses to which the water is put. In the larger manufacturing cities the water is generally used to a considerable extent by the factories, and in those cities where this is the case the consumption per person is large. In the smaller manufacturing cities and towns, although some water may be used for manufacturing and mechanical purposes, it is less likely to be so used as it is generally possible to obtain a satisfactory supply from some other source at a less cost, if the quantity used is large. There has been a rapid increase recently in the number of private water supplies in manufacturing towns where large consumers are seeking to obtain supplies of water independent of the public works, and in some cases the introduction of such supplies has had a decided effect in reducing the consumption of water from the public works in recent years. The quantity of water used for domestic purposes in these places is less as there

are apt to be fewer fixtures in the houses and little water is used for the sprinkling of lawns, etc. In the suburban cities and towns the use of water for domestic purposes is probably greatest. The following table shows the average consumption of water during the year 1900 in various groups of cities and towns classified according to the character of the city or town. The first group contains the cities and towns supplied by the metropolitan water district, which includes the city of Boston, the large suburban cities of Somerville and Chelsea and many other smaller suburban cities and towns. The second group contains those suburban cities and towns which are not included in the metropolitan water district. In these places there are large areas of lawns on which considerable water is used during the summer season. The third group contains the larger manufacturing cities, like Lowell, Fall River and New Bedford, and the fourth group contains the smaller manufacturing cities and towns. The last group includes the towns which are used to a large extent as summer resorts, where the consumption of water is very much increased by the increased population during the summer months.

Average Consumption per Person per Day in 1900.

	Gallons.
Metropolitan water district,	113
Average of 11 suburban cities and towns,	69
Average of 12 larger manufacturing cities,	60
Average of 33 smaller manufacturing cities and towns,	42
Average of 7 summer resorts,	66

Upon the introduction of water into a city or town it has been used at first by a comparatively small number of the people, but the number supplied has increased rapidly in most cases from year to year, until after a few years water is supplied to practically the whole population. At the same time the number of plumbing fixtures in the houses gradually increased, and the water was used for an increasing number of purposes. In order to show the increase in the consumption of water with the age of a works the following table is given, which shows the average consumption of water in 24 cities and towns during the first ten years after a water supply was introduced.

Table showing the Increase in the Consumption of Water per Person with the Age of the Works (Average of Twenty-four Cities and Towns).

Year after Water was introduced.	Average Consumption per Person per Day.	Year after Water was introduced.	Average Consumption per Person per Day.
First,	23	Sixth,	37
Second,	28	Seventh,	39
Third,	30	Eighth,	40
Fourth,	32	Ninth,	42
Fifth,	36	Tenth,	43

When a sewerage system is introduced into a city or town the tendency is to increase the consumption of water as more plumbing fixtures are introduced into the houses, and the water is used more freely if there is a ready means of disposing of the sewage. The cities of Newton, Waltham and Marlborough were practically without sewers until a general system was introduced, and then within a few years nearly all of the built-up portions of these cities were provided with sewers. The effect of the introduction of a sewerage system is indicated in the following table, which gives the average consumption of water per person per day in the three cities for seven years before the introduction of the sewer system and for nine years subsequent to the introduction of sewers.

Average Consumption of Water in Three Cities before and after the Introduction of a fairly Complete System of Sewers.

[Gallons per Person per Day.]

City.	Years previous to Introduction of Sewers.							Year when System of Sewers was practically completed.	Years subsequent to Introduction of Sewers.								
	7	6	5	4	3	2	1		1	2	3	4	5	6	7	8	9
Marlborough,	13	17	20	21	24	24	25	26	30	30	35	34	37	37	38	38	36
Newton,	28	31	33	33	31	36	40	42	50	52	60	65	63	60	57	63	62
Waltham,	37	36	39	33	31	32	33	40	47	53	61	59	71	70	76	88	90

It will be seen that, whereas the consumption of water during the seven years preceding the introduction of sewers was increasing at a slow rate, during the nine years succeeding the introduction of sewers the increase has been very large.

A considerable portion of the water supplied from a public works is wasted in various ways, and the quantity wasted varies in the different cities and towns. The principal wastes are from leaking fixtures in the houses or carelessness in the use of the water, and from leaks in the street mains or service pipes. To prevent or reduce the wastes due to the former cause meters have been placed upon the service pipes in many cities and towns and a charge is made for the water proportioned to the quantity used. The tendency of this system is to reduce the waste of water to a very great degree. In order to show the difference between the consumption of water in those cities and towns in which the water supply is largely sold at meter rates and those in which a fixed annual price is charged for the use of water which is not measured the following table is presented. This table shows the average consumption of water in 1900 (1) in the cities and towns in which more than 75 per cent. of the services are provided with meters; (2) in those in which between 25 per cent. and 75 per cent. of the services are provided with meters, and (3) those in which less than 25 per cent. of the services are metered.

Average Daily Consumption of Water per Person in 1900 in Cities and Towns, arranged in Groups according to the Percentage of Services which are provided with Meters.

	Gallons per Person.
Average of 14 cities and towns in which more than 75 per cent. of the services are metered,	39.8
Average of 24 cities and towns in which more than 25 per cent. but less than 75 per cent. of the services are metered,	47.1
Average of 31 cities and towns in which not more than 25 per cent. of the services are metered,	59.7

Meters have not been used to any large extent in this State until within comparatively recent times, and the effect of the general introduction of meters in the cities or towns is very marked. The following table gives the average consumption of water for the past ten years for those cities in which the percentage of metered services has increased more than 15, and in those cities and towns in which the percentage of metered services has increased less than 15. It will be noticed that the consumption of water per person in those places where meters have been introduced has increased much less than in those places in which comparatively few meters have been put in during the past ten years.

Increase in the Consumption of Water During the Past Ten Years compared with the Increase in the Number of Metered Services during the Same Period.

[Gallons per Person per Day.]

Year.	Average of 17 Towns in which the Percentage of Metered Services has increased more than 15 during the Past Ten Years.	Average of 23 Towns in which the Percentage of Metered Services has increased less than 15 during the Past Ten Years.	Year.	Average of 17 Towns in which the Percentage of Metered Services has increased more than 15 during the Past Ten Years.	Average of 23 Towns in which the Percentage of Metered Services has increased less than 15 during the Past Ten Years.
1891, . .	39	43	1896, . .	47	53
1892, . .	40	46	1897, . .	45	54
1893, . .	43	49	1898, . .	45	55
1894, . .	44	52	1899, . .	48	62
1895, . .	46	50	1900, . .	48	64

In those places in which practically all of the services are metered there is generally a great discrepancy between the quantity of water pumped, as shown by the pumping records, and the quantity of water passed through the meters, as indicated by the meter readings. Statistics have been obtained regarding the quantity of water passed through meters during 1900 in several of the cities and towns in which a large proportion of the services are metered. The following table gives the quantity of water pumped and the quantity of water passed through the meters in these places where statistics have been obtained. The cause of this difference, which may be due to leakage in the pipes or imperfect meters, or errors in the rating of the pumps, or, possibly, a combination of two or more of these and other circumstances, has not been definitely ascertained in most cases.

Table showing the Relation between the Quantity of Water passed through Meters and the Total Quantity of Water pumped in 1900 in those Cities and Towns in which a Large Proportion of the Services are provided with Meters.

City or Town.	Number of Services.			Per Cent. of Metered Services.	Total Quantity of Water Pumped in 1900 (Gallons).	Quantity passed through Meters (Gallons).	Per Cent. passed through Meters.
	Metered.	Unmetered.	Total.				
North Attleborough,	846	0	846	100	95,800,000	35,658,000	37
Weston, . .	128	0	128	100	19,019,000	8,000,000	42
Winchendon, . .	373	14	387	96	20,542,000	9,697,000	47
Ware, . . .	735	39	774	95	104,744,000	59,778,000	57
Fall River, . .	6,544	399	6,943	94	1,388,776,000	772,909,000	56
Worcester, . .	12,536	756	13,292	94	2,975,716,000	1,614,623,000	54
Reading, . . .	962	96	1,058	91	54,250,000	33,450,000	62
Wellesley, . .	799	79	878	90	87,194,000	46,279,000	53
Newton, . . .	6,001	1,086	7,087	85	761,526,000	419,000,000	55
Brockton, . . .	4,300	975	5,275	82	429,002,000	218,179,000	51
Lawrence, . .	4,651	1,392	6,043	77	1,210,632,000	525,047,000	43
Attleborough, . .	957	508	1,465	65	165,174,000	65,523,000	40
Lowell, . . .	5,586	5,048	10,634	53	2,881,075,000	775,194,000	27
Marlborough, . .	1,141	1,103	2,244	51	179,922,000	66,055,000	37
Orange, . . .	299	293	592	51	57,571,000	14,776,000	26
Framingham, . .	562	668	1,230	46	157,840,000	66,502,000	42
Foxborough, . .	212	246	458	46	64,206,000	8,733,000	14
Norwood, . .	461	584	1,045	44	145,821,000	35,054,000	24
Middleborough, .	349	479	828	42	85,092,000	41,102,000	48
Taunton, . . .	1,832	2,670	4,502	41	600,323,000	221,532,000	37
Walpole, . . .	150	304	454	33	58,532,000	27,214,000	46

The consumption of water in Massachusetts cities and towns is still increasing at a greater rate than the population, notwithstanding the efforts that have been made in recent years to prevent it, by the introduction of meters and by inspection. The increase in the consumption of water in census years between 1890 and 1900 in 40 cities and towns in which works had been in general use previous to 1890, and in which records have been kept, and in the cities and towns constituting the metropolitan water district, is shown by the following table: —

Consumption of Water in Census Years between 1890 and 1900 in 40 Cities and Towns and in the Cities and Towns constituting the Metropolitan Water District.

City or Town.	1890.			1895.			1900.		
	Population.	Average Daily Consumption (Gallons).	Consumption per Person (Gallons).	Population.	Average Daily Consumption (Gallons).	Consumption per Person (Gallons).	Population.	Average Daily Consumption (Gallons).	Consumption per Person (Gallons).
Abington and Rockland,	9,473	312,000	33	9,730	407,000	42	9,816	373,000	38
Ayer, ...	2,148	61,000	28	2,101	73,000	35	2,446	90,000	37
Beverly, ...	10,821	743,000	69	11,806	809,000	69	13,884	1,003,000	72
Braintree, ...	4,848	161,000	33	5,311	308,000	58	5,981	544,000	91
Bridgewater, ...	7,160	85,000	12	7,580	164,000	22	8,831	223,000	25
Brookline, ...	12,103	877,000	72	16,164	1,318,000	82	19,935	1,941,000	97
Cambridge, ...	70,028	4,566,000	65	81,643	6,074,000	74	91,886	7,304,000	80
Cohasset, ...	2,448	49,000	20	2,474	65,000	26	2,759	129,000	47
Danvers and Middleton, .	8,378	484,000	58	9,019	602,000	67	9,381	676,000	72
Dedham, ...	7,123	223,000	31	7,211	419,000	58	7,457	586,000	79
Easton, ...	4,493	93,000	21	4,452	82,000	18	4,837	114,000	24
Fall River, ...	74,398	2,136,000	29	89,203	3,167,000	35	104,863	3,805,000	36
Framingham, ...	9,239	204,000	22	9,512	362,000	38	11,302	433,000	38
Franklin, ...	4,831	74,000	15	5,136	201,000	39	5,017	173,000	34
Lawrence, ...	44,654	2,778,000	62	52,164	3,005,000	58	62,559	3,317,000	53
Lowell, ...	77,696	5,374,000	69	84,367	6,922,000	82	94,969	7,893,000	83
Lynn and Saugus, . .	59,400	2,657,000	45	66,851	4,360,000	65	73,597	4,680,000	64
Mansfield, ...	3,432	145,000	42	3,722	125,000	34	4,006	133,000	33
Marlborough, ...	13,805	348,000	25	14,977	510,000	34	13,609	493,000	36
Middleborough, . . .	6,065	129,000	21	6,689	212,000	32	6,885	233,000	34
Montague, ...	6,296	283,000	45	6,058	320,000	53	6,150	446,000	73
Nantucket, ...	3,268	70,000	22	3,016	89,000	30	3,006	125,000	42
Natick, ...	9,118	264,000	29	8,814	376,000	43	9,488	378,000	40
New Bedford, ...	40,733	4,066,000	100	55,251	4,712,000	85	62,442	6,321,000	101
Newburyport, ...	13,947	426,000	31	14,552	667,000	46	14,478	617,000	43
Norwood, ...	3,733	169,000	45	4,574	270,000	59	5,480	400,000	73
Peabody, ...	10,158	827,000	81	10,507	900,000	86	11,523	1,036,000	90
Randolph and Holbrook,	6,420	192,000	30	5,992	273,000	45	6,222	233,000	37
Salem, ...	30,801	2,184,000	71	34,473	2,163,000	63	35,956	2,712,000	75
Taunton, ...	25,448	807,000	32	27,115	1,153,000	43	31,036	1,645,000	53
Wakefield, ...	13,137	537,000	41	14,588	612,000	42	15,487	1,091,000	70
Waltham, ...	18,707	626,000	33	20,876	1,222,000	59	23,481	2,118,000	90
Ware, ...	7,329	160,000	22	7,651	241,000	31	8,263	286,000	35
Wellesley, ...	3,600	255,000	71	4,229	175,000	41	5,072	239,000	47
Whitman, ...	4,441	87,000	20	5,744	188,000	33	6,155	133,000	22
Woburn, ...	13,499	777,000	58	14,178	1,039,000	73	14,254	1,116,000	78
Totals and averages, .	643,178	33,229,000	52	727,730	43,585,000	60	812,513	53,039,000	65
Cities and towns constituting metropolitan district,* . . .	639,303	46,881,000	73	748,117	68,882,000	92	860,934	97,114,000	113

* The consumption in Medford and Arlington during 1890 and 1895 has been estimated, since no measurements of the quantity of water used were made in those places.

The quantity of water used in the metropolitan district is greater in proportion to the population than in any of the smaller municipalities of the State, but not so great as in many of the great cities of the United States. It will be seen that the consumption of water is increasing rapidly, both in the metropolitan district and in the cities and towns outside of the district. The increase in the five years from 1890 to 1895 was 26 per cent. in those cities and towns which now comprise the metropolitan district, and 15 per cent. in the cities and towns outside of the district. In the five years from 1895 to 1900 the increase in the cities and towns in the metropolitan district was 23 per cent. and in the cities and towns outside the district, 8 per cent.

All of the foregoing tables show only the yearly consumption of water. During each year there is a considerable monthly variation and a still greater weekly or daily variation in the quantity of water used. This variation is due to a variety of causes, but the chief cause is the use of an excessive quantity of water during dry weather for sprinkling lawns, gardens and streets, and the consumption varies with the degree of heat and dryness of the season. During the coldest period of the year there is usually an increase in the consumption of water, due to the waste of water from faucets to prevent the pipes within the houses from freezing.

The following table gives the percentage which the consumption during each month is of the average consumption for the year in which the month occurs for each year from 1896 to 1900, inclusive, and is the average of cities and towns from which reports were received. The average monthly rainfall in Massachusetts at several stations geographically selected and the average temperature from the same stations are also presented. It will be seen that, in general, the consumption of water is influenced by the amount of rainfall and the degree of heat. It will also be noticed that during the cold months there is an increase in the consumption of water, due to the causes already stated.

Per Cent. which the Consumption during Each Month is of the Average Monthly Consumption of reporting Cities and Towns during the Year, from 1896–1900, inclusive, together with the Rainfall and Average Monthly Temperature.

Month.	Per Cent. which Consumption is of Average for Year.	Rainfall (Inches).	Temperature. Deg. F.
1896.			
January,	90	1.97	22.5
February,	89	4.85	26.2
March,	87	5.90	29.7
April,	88	1.41	47.7
May,	110	2.54	60.6
June,	113	2.96	65.0
July,	125	3.82	71.4
August,	122	2.63	69.5
September,	102	6.67	60.3
October,	92	3.60	47.2
November,	87	2.99	43.7
December,	88	1.76	26.5
1897.			
January,	90	3.81	25.8
February,	92	2.51	27.4
March,	88	3.03	34.6
April,	90	2.89	47.6
May,	93	4.55	57.5
June,	106	5.03	62.0
July,	123	7.86	71.9
August,	116	4.70	67.4
September,	112	2.14	60.8
October,	102	0.80	51.3
November,	93	6.52	38.7
December,	93	4.67	30.9
1898.			
January,	91	5.53	25.1
February,	94	4.58	28.6
March,	90	2.07	40.4
April,	88	4.88	42.8
May,	91	4.72	55.8
June,	110	2.27	65.9
July,	124	4.55	71.3
August,	112	7.24	70.8
September,	112	2.33	64.0
October,	96	7.13	52.0
November,	90	6.62	38.8
December,	95	2.78	27.8
1899.			
January,	84	4.20	25.1
Febrnary,	91	4.64	23.1
March,	86	6.90	31.8
April,	86	1.74	45.9
May,	103	1.33	57.2
June,	135	3.30	68.3
July,	123	3.69	70.2
August,	120	2.04	67.9
September,	104	5.07	60.0
October,	92	2.55	52.4
November,	89	2.24	38.9
December,	85	1.78	32.1
1900.			
January,	83	4.43	26.9
February,	83	7.64	26.1
March,	83	5.03	31.0
April,	81	1.95	45.8
May,	90	4.88	54.8
June,	118	2.41	66.9
July,	141	2.68	71.8
August,	127	2.31	70.1
September,	121	3.71	64.0
October,	93	4.00	55.2
November,	91	5.23	41.9
December,	87	2.63	29.3

The difference in the yearly consumption of water in towns of different character has been shown in a previous table. There is also a very marked difference in the monthly variations in the consumption in these towns. This difference is especially marked in those towns used as places of summer resort. In order to show this difference the following table is presented, giving the average monthly fluctuations in the consumption of water for the year 1900 in the same groups comprised in the former table. In reckoning the gallons per person the population of the cities and towns by the census of the year 1900 has been used. In towns used as summer resorts the population is much greater in the summer season than is shown by the census figures. For this reason the quantity of water used per person as given in the table is doubtless very much greater than the quantity actually used.

Average Consumption of Water during Each Month in 1900, in Cities and Towns arranged in Groups.

[Gallons per Person per Day.]

Month.	Average of 12 Larger Manufacturing Cities.	Average of 11 Suburban Cities and Towns.	Average of 33 Smaller Manufacturing Cities and Towns.	Average of 7 Towns used as Summer Resorts.
January,	57	62	38	35
February,	59	62	37	34
March,	59	60	37	34
April,	54	60	37	37
May,	56	65	39	46
June,	64	78	47	108
July,	71	89	54	146
August,	65	76	48	143
September,	64	81	46	98
October,	58	68	41	43
November,	57	67	39	36
December,	58	64	38	38
Year,	60	69	42	66

In order to show the variation in the consumption of water for a shorter period than a month records have been kept for the past six years of the consumption during the maximum week and during the maximum day of each year, and the table which follows gives the averages of the records for the six years from 1895 to 1900, inclusive. These records are apt to be misleading in the case of the smaller towns, as they show the amount of water pumped and not the amount of water used, and in certain cases the amount of water pumped is excessive, owing to the filling of an empty reservoir or a serious leak in the distributing pipes.

Relation of the Consumption of Water during the Month, Week and Day of Maximum Consumption to the Average for the Year. — Average of Six Years from 1895 to 1900 inclusive.

City or Town.	Average Daily Consumption per Person.	Maximum Monthly Consumption.		Maximum Weekly Consumption.		Maximum Daily Consumption.	
		Gallons per Person per Day.	Per Cent. of Average for Year.	Gallons per Person per Day.	Per Cent. of Average for Year.	Gallons per Person per Day.	Per Cent. of Average for Year.
Abington and Rockland,	39	54	138	63	167	88	233
Andover,	54	67	127	74	129	150	264
Attleborough,	36	47	130	52	143	88	245
Avon,	31	42	137	55	180	109	367
Ayer,	37	51	140	66	181	96	266
Beverly,	70	98	140	114	163	156	222
Braintree,	71	85	123	83	143	137	194
Bridgewater and East Bridgewater.	24	27	116	31	130	41	175
Brockton,	30	40	134	49	164	69	232
Brookline,	85	105	124	146	160	167	184
Cambridge,	81	94	113	109	138	145	180
Canton,	40	54	134	64	158	87	216
Cohasset,	34	62	177	62	250	95	340
Cottage City,	93	251	271	296	318	383	419

Relation of the Consumption of Water during the Month, Week and Day of Maximum Consumption to the Average for the Year.— Average of Six Years from 1895 to 1900 inclusive— Concluded.

City or Town.	Average Daily Consumption per Person.	Maximum Monthly Consumption.		Maximum Weekly Consumption.		Maximum Daily Consumption.	
		Gallons per Person per Day.	Per Cent. of Average for Year.	Gallons per Person per Day.	Per Cent. of Average for Year.	Gallons per Person per Day.	Per Cent. of Average for Year.
Danvers,	69	84	119	96	134	127	181
Dedham,	71	91	127	103	149	126	183
Easton,	21	29	135	38	181	51	245
Fairhaven,	48	70	153	73	165	114	258
Fall River,	36	43	121	47	130	54	150
Foxborough,	50	60	119	68	135	100	200
Framingham,	36	44	122	52	143	71	194
Franklin,	35	47	136	72	206	82	245
Gardner,	62	77	125	86	128	113	169
Gloucester,	32	41	129	47	142	64	193
Hyde Park and Milton,	42	61	145	62	147	70	166
Ipswich,	18	32	173	29	160	100	542
Lawrence,	55	62	111	74	134	90	164
Longmeadow,	64	90	146	117	185	177	285
Lowell,	79	92	117	102	130	118	150
Lynn and Saugus,	67	78	116	84	125	118	177
Manchester,	76	142	186	163	214	224	296
Mansfield,	33	45	134	59	177	79	236
Marblehead,	49	79	160	92	187	127	264
Marlborough,	37	43	119	44	119	80	220
Maynard,	30	43	143	57	180	140	482
Methuen,	33	42	126	51	151	80	217
Middleborough,	32	41	125	51	160	72	218
Milford and Hopedale,	61	74	121	83	136	97	158
Montague,	67	80	122	89	127	132	202
Nantucket,	32	70	218	80	249	95	296
Natick,	42	56	134	80	191	135	322
Needham,	50	57	114	64	128	79	158
New Bedford,	96	108	113	121	126	145	151
Newburyport,	41	46	114	52	128	64	157
North Attleborough,	30	40	136	39	138	53	176
North Brookfield,	35	45	134	62	184	103	308
Norwood,	71	84	119	89	129	176	261
Orange,	24	31	130	42	173	70	300
Peabody,	89	102	114	113	127	139	155
Provincetown,	29	52	187	67	224	127	480
Randolph and Holbrook,	45	72	161	96	226	131	306
Reading,	32	51	154	69	206	111	328
Rockport,	34	53	151	73	194	89	266
Salem,	67	77	114	80	119	119	178
Sharon,	26	57	216	67	258	88	336
Stoughton,	43	52	122	59	146	77	192
Taunton,	46	53	116	58	127	67	147
Tisbury,	37	74	196	93	253	110	304
Wakefield and Stoneham,	53	66	124	57	127	102	182
Walpole,*	30	40	136	61	188	91	328
Waltham,*	76	84	115	99	135	134	188
Ware,	32	40	123	43	133	92	283
Webster,	34	39	117	42	125	59	175
Wellesley,	42	54	130	66	157	82	236
Whitman,	29	42	149	54	188	66	231
Woburn,	73	90	123	106	145	160	218
Worcester,†	58	75	117	86	128	110	165

* Five years only. † Less than 6 years.

In order to ascertain what the consumption of water is during a very cold period in the winter requests were sent out for information in regard to the consumption of water during a very cold week in February, 1899. Replies were received from many of the cities and towns, and the information is presented in the following table : —

Consumption of Water during a Cold Period in February, 1899.

City or Town.	Population. 1899.	Per Cent. of Services Metered.	Average Daily Consumption per Person during Year (Gallons).	Average Daily Consumption per Person during Week of Maximum Consumption (Gallons).	Per Cent of Average for Year.	Average Daily Consumption per Person during Cold Week (Gallons).	Per Cent. of Average for Year.
Attleborough,	10,726	61	34	46	135	33	97
Avon,	1,718	3	33	63	191	25	76
Ayer,	2,377	17	40	63	157	33	82
Beverly,	13,470	2	71	129	182	–	–
Brockton,	38,683	80	29	49	169	30	103
Brookline,	19,181	48	92	146	159	95	103
Cambridge,	89,837	4	87	148	170	148	170
Canton,	4,594	32	45	78	173	41	91
Cohasset,	2,702	–	47	–	–	85	181
Dedham,	7,408	2	82	–	–	75	91
Easton,	4,760	25	22	48	218	22	100
Fairhaven,	3,521	22	61	85	139	69	113
Fall River,	101,731	94	35	48	137	30	86
Foxborough,	3,257	45	60	83	138	46	77
Framingham,	10,944	38	38	58	153	50	132
Gloucester,	26,539	2	37	55	149	46	124
Hyde Park and Milton,	19,642	–	57	65	114	42	93
Lawrence,	60,480	74	53	76	145	54	102
Mansfield,	3,949	31	35	66	189	35	100
Marblehead,	7,600	–	60	105	175	59	98
Middleborough,	6,846	42	33	54	164	33	100
Montague,	6,132	2	70	94	134	90	128
Nantucket,	3,008	–	37	85	230	24	65
Natick,	9,353	27	42	76	181	52	124
Needham,	3,915	99	58	70	121	61	105
New Bedford,	61,004	12	101	138	137	138	137
Newburyport,	14,493	2	40	56	140	41	102
Norwood,	5,299	41	80	99	124	98	122
Peabody,	11,320	–	100	129	129	88	88
Provincetown,	4,309	10	38	70	184	18	47
Randolph,	6,176	–	47	99	211	38	81
Reading,	4,919	90	27	49	181	26	96
Rockport,	4,731	2	40	69	173	40	100
Salem,	35,659	2	70	92	131	87	124
Sharon,	1,991	11	32	86	269	21	66
Stoughton,	5,408	61	47	72	153	56	119
Taunton,	30,252	40	48	64	133	52	108
Walpole,	3,456	30	42	72	171	44	105
Waltham,	22,960	2	88	–	–	94	107
Ware,	8,141	94	35	50	143	–	–
Webster,	8,603	37	35	40	114	37	106
Wellesley,	4,903	92	44	68	155	36	82
Whitman,	6,073	47	27	54	200	26	96
Woburn,	14,239	2	78	116	149	80	103

It is interesting to note that while the consumption of water in many of the municipalities in which more or less careful records of consumption are kept is quite large and continues to increase, studies and estimates of the quantity of water used in many other cities and towns, in which the water is supplied wholly by gravity and no attempt to measure the quantity used is made, show that the quantity supplied to such cities and towns is probably very much larger, on the average, than in cases where all of the water is pumped or records of the quantity used are kept. In some places, in which no measurement of the quantity of water supplied is kept, there are indications that the quantity used in proportion to the population is excessive. While pumping records may not be very reliable evidence in all cases of the quantity of water supplied to a city or town, they nevertheless serve, as a whole, to give a very fair indication of the quantity of water being used, and show quite clearly when the quantity supplied is becoming excessive. In cases where water is supplied by gravity it is generally considered unnecessary and often a waste of money to attempt to make any continuous and approximately correct record of the quantity of water used. There is no doubt, however, that in many such cases a knowledge of the excessive use of water would lead to a great reduction in waste and to a saving in the cost of construction and operation of the works far greater than the expense of making the necessary measurements.

FOOD AND DRUG INSPECTION.

FOOD AND DRUG INSPECTION.

The following report deals with the work of the Board under the acts relating to food and drug inspection for the year ended Sept. 30, 1900.

By the terms of the food act of 1882 the Board is required to "report annually to the Legislature the number of prosecutions made under chapter 263 of the Acts of 1882, and an itemized account of all money expended in carrying out the provisions thereof."

This report was made to the Legislature in January, 1901, and is also embodied in the following detailed report of observations for the fiscal year ended Sept. 30, 1900.

The general supervision of the work has been carried out under the direction of the secretary, as in former years, including the collection of samples, their examination by the analysts, the prosecution of offenders, and other necessary work under these statutes, including the correspondence with such parties as may have a direct interest in these statutes, either in the State or out of it.

This correspondence in recent years has been unusually large, in consequence of the constant sale of articles of food in Massachusetts, which are prepared in other States, where different laws prevail.

The following persons comprised the force employed by the Board during the year in this department of work: —

Albert E. Leach,	*Analyst.*
C. A. Goessmann,	*Analyst.*
Hermann C. Lythgoe,	*Assistant Analyst.*
John F. McCaffrey,	*Inspector.*
John H. Terry,	*Inspector.*
Horace F. Davis,	*Inspector.*
Thomas O. Allen,	*Inspector.*

The number of samples of food and drugs examined during the year is shown in the following table, and the following pages con-

tain a complete summary of the work done since and including 1883 : —

Number of samples of milk examined,	6,232
Number of samples above standard,	4,431
Number of samples below standard,	1,801
Percentage of adulteration or deficiency,	28.9
Number of samples of other kinds of food examined (not milk),	3,132
Number of samples above standard,	2,670
Number of samples below standard,	462
Percentage of adulteration,	14.2
Number of samples of drugs examined,	758
Number of samples of good quality,	377
Number of samples adulterated (as defined by the statutes),	381
Percentage of adulteration,	50.2
Total number of food and drugs examined,	10,122
Total number found to be of good quality,	7,478
Total number not conforming to the statutes,	2,644
Percentage of adulteration,	26.1

STATISTICAL SUMMARY.

FOOD AND DRUG INSPECTION (1883-1900).

SUMMARY.	YEARS.									
	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
Number of samples of milk examined,	218	1,123	2,219	2,085	3,081	2,825	3,219	3,236	2,726	3,271
Number of samples above standard,	35	347	1,297	1,323	1,900	1,705	1,971	1,858	1,629	1,757
Number of samples below standard,	183	776	922	762	1,181	1,120	1,248	1,378	1,097	1,514
Percentage of adulteration,	83.9	69.1	41.7	36.5	38.3	39.6	38.7	42.6	40.2	46.3
Number of samples of other kinds of food examined (not milk),	477	839	1,552	1,353	1,789	2,079	1,635	2,349	2,144	2,441
Number of samples of good quality,	328	432	883	863	1,263	1,680	1,242	1,913	1,577	2,042
Number of samples adulterated, as defined by the statutes,	149	407	669	490	556	399	393	436	567	399
Percentage of adulteration,	31.2	48.5	43.1	36.2	29.4	19.2	24.0	18.6	26.4	16.3
Number of samples of drugs examined,	603	682	1,007	888	550	862	600	400	424	487
Number of samples of good quality,	357	431	571	463	400	634	503	325	352	312
Number of samples adulterated, as defined by the statutes,	246	251	436	425	150	228	97	75	72	175
Percentage of adulteration,	40.8	36.8	43.3	47.8	27.3	26.4	16.2	18.7	17.0	35.9
Total examinations of food and drugs,	1,298	2,644	4,778	4,326	5,420	5,766	5,454	5,985	5,294	6,199
Total examinations of good quality,	720	1,210	2,751	2,649	3,563	4,019	3,716	4,096	3,558	4,111
Total examinations not conforming to the statutes,	578	1,434	2,027	1,677	1,857	1,747	1,738	1,889	1,736	2,088
Percentage of adulteration,	44.5	54.2	42.7	38.7	34.3	30.3	31.9	31.5	32.8	33.7
Expense of collection, examination and prosecution,	$2,931 56	$5,529 60	$8,557 43	$8,025 34	$8,803 62	$8,915 41	$10,356 28	$10,013 04	$10,019 41	$11,180 30
Expense of collection, examination and prosecution, per sample,	2 26	2 09	1 79	1 85	1 62	1 54	1 89	1 67	1 89	1 80

FOOD AND DRUG INSPECTION (1883-1900) — *Concluded.*

SUMMARY.	YEARS.								TOTALS.
	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	
Number of samples of milk examined,	3,073	3,551	3,794	4,484	6,046	6,247	6,186	6,232	63,616
Number of samples above standard,	1,545	1,794	1,905	2,904	4,150	4,307	4,506	4,431	39,364
Number of samples below standard,	1,528	1,757	1,889	1,580	1,896	1,940	1,680	1,801	24,252
Percentage of adulteration,	49.7	49.5	49.8	35.2	31.3	31.1	27.2	28.9	38.1
Number of samples of other kinds of food examined (not milk),	3,009	2,836	2,971	3,368	3,944	3,738	3,069	3,132	42,725
Number of samples of good qnality,	2,637	2,566	2,379	2,978	3,438	3,238	2,615	2,670	34,744
Number of samples adulterated, as defined by the statutes,	372	270	592	390	506	500	454	462	7,981
Percentage of adulteration,	12.3	9.5	19.9	11.6	12.8	13.4	14.8	14.2	18.7
Number of samples of drugs examined,	327	487	544	505	690	812	547	758	11,173
Number of samples of good quality,	228	324	212	251	442	531	303	377	7,016
Number of samples adulterated, as defined by the statutes,	99	163	332	254	248	281	244	381	4,157
Percentage of adulteration,	30.3	33.5	61.0	50.3	35.9	34.6	44.6	50.2	37.2
Total examinations of food and drugs,	6,409	6,874	7,309	8,357	10,680	10,797	9,802	10,122	117,514
Total examinations of good quality,	4 ,410	4,684	4,496	6,133	8,030	8,076	7,424	7,478	81,124
Total examinations not conforming to the statutes,	1,999	2,190	2,813	2,224	2,650	2,721	2,378	2,644	36,390
Percentage of adulteration,	31.2	31.9	38.5	26.6	24.8	25.2	24.3	26.1	31.0
Expense of collection, examination and prosecution,	$10,454 11	$10,364 64	$11,375 89	$10,921 61	$12,076 43	$11,062 68	$11,251 83	$11,108 73	$172,947 91
Expense of collection, examination and prosecution, per sample,	1 63	1 52	1 56	1 23	1 13	1 02	1 15	1 10	1 47

Comment has often been made in previous reports of the Board upon the fact that the foregoing figures have scarcely any significance as showing the actual ratio of adulteration prevailing in the State. Neither absolutely, as a bald statistical statement, nor relatively, comparing the results of one year with those of another, or those of one general group of articles with other groups, can the figures be interpreted as showing anything more than a certain gross amount of work performed in this department. When special articles are considered, however, as was shown by the report of last year (page 481), great improvement has been evident.

Effect of Legislation. — One of the most decided factors influencing a series of figures like the foregoing tables is legislation itself. For example, as shown by the report of the analyst, on page 650, about 75 per cent. of all samples of milk examined during the past year contained between 12 and 14 per cent. of solids, and over 40 per cent. contained between 12 and 13 per cent. The law at first required that all milk containing less than 13 per cent. of solids should be deemed to be adulterated; and since a considerable ratio of samples of milk as naturally produced by the cow, and a considerably larger number of samples as actually obtained from dealers in milk, contain less than 13 per cent. of solids, any reduction in this standard, other things being equal, would diminish the apparent ratio of adulteration, without any actual change having occurred in the quality of this valuable article of food. No sudden change was made by legislation, but laws have been enacted from time to time, first making the standard 12 per cent. in two months of the year, then in five months, and finally in six months.

Again, the law of 1900 relative to arsenic in fabrics and wall papers led to further work upon the presence of arsenic in food products and in drugs, with the result that certain articles containing appreciable quantities of arsenic were deemed to be adulterated, and these articles, obtained in considerable numbers, when found to contain even relatively small amounts of arsenic, are placed in the column of adulterated articles. Articles subject to this form of adulteration cannot be classed with fraudulent articles, since the impurity is of a character which is purely accidental. It is, however, avoidable, since a very considerable portion of the articles examined are found to be free from its presence. While very minute quantities of arsenic may be tolerated in household articles

not intended for internal use as food or medicine, all food preparations ought to be made absolutely free from arsenic. While the law now recognizes an allowable limit* of this poison in certain articles intended for domestic use, it specially states in the case of food and drugs that they must not contain "any added poisonous ingredient."

Employment of Counsel. — In the food and drug act of 1882 it was provided that the State Board of Health should "take cognizance of the interests of the public health relating to the sale of drugs and food and the adulteration of the same;" and by a later act the Board was required to "report annually to the Legislature the number of prosecutions made under" these acts. The work of the Board under these acts has been conducted without interruption from 1883 until the present time, the total number of samples collected and examined up to Oct. 1, 1900, having been 117,514, and the number of prosecutions conducted 1,476, of which 92.3 per cent. resulted in conviction.

As might have been expected, under the operation of an entirely new statute, in which many perplexing questions were liable to arise with reference to the proper methods of introducing complaints at court and of conducting cases of adulteration requiring prosecution, it was at first found to be necessary to employ legal counsel. Consequently, an attorney was employed for this purpose, and the complaints were carefully prepared by him. As the inspectors gradually familiarized themselves with this department of the work, they began to conduct all ordinary cases in which the evidence was clear, and in which no difficult legal points had arisen. By this course the Board has been able to dispense entirely with the necessity of resorting to the employment of counsel during the last six years of its work under the provisions of the food acts. The entire cost of attorney's fees from the beginning of work in 1883 was only $1,639.63, and during the last six years nothing has been paid in this direction. In consequence of this fact, it has been possible to devote the entire amount of the appropriation for this special line of work to the collection of samples and their examination.

Neither is the cost of supervision included in this account, since from the beginning of work in this department in 1883 the supervi-

* One-tenth grain per square yard in wall papers, and one-hundredth grain in other fabrics, such as dress goods, upholstery, etc.

sion of the food and drug inspection has been conducted by the Board under its appropriation for general expenses, and without any extra charge for such supervision. By this method of operation it has been possible to conduct a much greater share of work than could otherwise have been done; while in other States, having a special commission for this line of work, not only has a considerable share of the expenditure been devoted to the cost of supervision, but also a very considerable share (sometimes fully one-third of the entire cost of the department) has been used in defraying the expenses of employing counsel in the matter of conducting cases at court.

Of all the different sorts of food, milk is most liable to fraud, for the reason that the chief article used in its adulteration (water) costs the manipulator nothing at all. On this account, and in consequence of the requirements of the statute, three-fifths of the entire appropriation expended in this department is devoted to the inspection of this valuable article of food, with the other allied products into whose composition it enters as the chief ingredient, — butter and cheese.

The perishable nature of milk makes it necessary to adopt measures for its inspection different from those which are employed in the case of other articles. The examination must be made within a few hours after the samples are taken, since they are often from several hours to two or three days old when sold to the consumer. For this reason, a local inspector in the cities and large towns is the best form of inspection when efficiently carried out. The inspector can make frequent inspections, and conduct his analyses very soon after the milk is taken. Most of the cities and some of the large towns now employ inspectors for this purpose. Such practice is compulsory in the cities and permissible in the towns.

In a large town having about 9,000 inhabitants but no milk inspection, it was found that one or more milk dealers were seriously adulterating their product. A citizen asked that an article should be introduced into the town warrant, calling for the appointment of an inspector. At the time of the meeting, when the article was called up for action of the meeting, he stated that the town was annually paying considerably more for the milk consumed by the citizens than was paid for the support of the public schools. For the

latter, however, an efficient superintendent was employed, with an appropriate salary. On the other hand, the annual cost of the milk used was estimated at about 30 per cent. more than the cost of the schools, and no supervision whatever had been provided for it. A motion to appoint an inspector was carried without debate, a moderate appropriation was provided, and a competent chemist found to undertake the work. From that time to the present the town has had constant supervision of its milk supply.

In several cities and towns the office of milk inspector is merely a sinecure, since the inspector contents himself with simply fulfilling the duty of collecting the license fees of milkmen and possibly of sending a dozen samples in each year to a chemist for analysis. Such a system is milk inspection in name only.

Comment has frequently been made in the reports of the Board upon the fact that very many of the staple articles of food are but little subject to adulteration. Almost the only adulterant found in flour, for example, has been some sort of flour of a cheaper quality, like that of Indian corn or other cereal, and this has occurred only in rare instances in Massachusetts. Cane sugar also is very rarely subject to adulteration, although when used in compounding other articles of food its place is often supplied by glucose, in consequence of the cheapness of the latter. The special forms of sugar which sell at higher price, such as maple sugar, are very much adulterated, the adulterant usually consisting of ordinary cane sugar, either crude or refined. It is nearly or quite identical in composition with cane sugar. Beet sugar, now becoming every year an increasing product of American manufacture, is identical with cane sugar, and cannot be distinguished from it. In many countries these two are sold at about the same price. Molasses and syrups are much subject to adulteration with glucose.

Fines. — The amount of fines collected and turned into the treasuries of cities and counties during the period in which the food and drug acts have been in force has to some extent balanced the cost of enforcement of the statutes, having averaged over $2,500 per year since 1887. The enactment of a law, however, in 1900, by the provisions of which the judge could impose a smaller fine in cases of milk adulteration in which it is only proven that the milk is below legal standard, will undoubtedly have a tendency to reduce quite materially the amount of money collected from this source. A

further explanation of this topic may be found in the analyst's report.

Drugs. — A reasonable degree of attention has been paid during the year to the examination of drugs, the whole number examined having been 758, of which 381, or a little more than one-half, were found not to conform to the standard required by the statutes. This excessive ratio is due to the fact that the drugs selected for examination were those which are most liable to adulteration. In a few instances the fact of adulteration is plainly due to deliberate fraud, but in many it is the result either of carelessness, accident or other unintentional causes. The principal drugs found to be adulterated were chlorinated lime, the preparations of opium, glycerine, the pharmacopœial wines, liquors and spices, and distilled water.

The examination of glycerine for arsenic has revealed its presence in a majority of the samples obtained. But the fact that a considerable number were free from this dangerous impurity sufficiently disproves the claim that glycerine cannot be made arsenic free. Extensive correspondence with manufacturers of this article and further examination of the product as sold in the State shows a decided improvement in this direction. Whatever may be said as to the propriety of allowing a certain limit of arsenic in ordinary articles not intended for internal use, it should be excluded from drugs as an impurity of more than doubtful character. The extensive use of sulphuric acid in very many processes of manufacture, not only in the arts but also in the preparation of drugs, chemicals and articles of food, ought to lead to a discrimination in the quality of the acid employed for different purposes. It was the neglect of this precaution which led to the serious epidemic of arsenical poisoning which occurred in England during the past year.

Methods of Procedure under the Food and Drug Acts. — In the recent reports of the Board no general description has been presented of the methods of procedure which have been adopted for carrying out the provisions of the food and drug acts. A brief statement is herewith presented of these methods by which the provisions of the different acts relating to food and drug inspection are carried out.

The general statute relating to this subject was enacted in 1882, chapter 263, and required the State Board of Health to "take cognizance of the interests of the public health relating to the sale of drugs

and food and the adulteration of the same," and to "make all necessary investigations and inquiries in reference thereto," and for these purposes "the board was authorized to appoint inspectors, analysts and chemists." The Board was also required, by the same act, to "adopt such measures as it may deem necessary to facilitate the enforcement hereof, and to prepare rules and regulations with regard to the proper methods of collecting and examining drugs and articles of food." This general act has been amended by several laws which have been enacted since 1882, some of which were of a general character, and others related to special articles of food.

The principal general laws were those of 1884 and of 1897. The former was virtually a re-enactment, with slight modifications, of the law of 1882. That of 1897 related principally to articles of food, and, after stating in nearly the same language the general definitions of food adulteration of the act of 1884, contained the following proviso: "*provided*, that the provisions of this act shall not apply to mixtures or compounds recognized as ordinary articles of food, if every package sold or offered for sale is distinctly labelled as a mixture or compound, *with the name and per cent. of each ingredient therein*, and if such mixtures or compounds are not injurious to health."

The italicized words in the foregoing paragraph constitute the principal amendment to the original act of a general character. Other sections contained special provisions relating to the sale of canned goods, syrups and molasses.

Under the authority of these acts, the Board was empowered to "appoint inspectors, analysts and chemists," for the purpose of carrying out the provisions of the law. The duties of the inspectors are "to procure samples of drugs and articles of food at such times and places as the secretary shall direct" in the manner provided by the statutes (see regulations of the Board, as published in the "Manual of Health Laws").

These samples are obtained at the different places of business where food or drugs are kept for sale, and in the case of milk, from wagons from which it is delivered for sale, as well as from markets, bakeries and other places where milk is sold, and when occasion requires, they are also obtained from the producer's dairies.

In order that the samples may be identified by the chemist, the inspector is required after each sale to affix a number to each sample,

in such manner as may be prescribed. He must not convey to the analyst any information as to the source from which the sample is obtained (Regulation 3).

He is also required to keep the following record of each sample in a book provided for the purpose: —

(*a*) The inspector's number.

(*b*) The date of purchase or receipt of sample.

(*c*) The character of the sample.

(*d*) The name of the vendor.

(*e*) The name of the city or town and street and number where the sample is obtained, and, in the case of a licensed milk pedler, the number of his license.

(*f*) As far as possible, the names of manufacturers, producers or wholesalers, with marks, brands or labels stamped or printed upon goods (Regulation 4).

These samples are transmitted to the analysts by the inspectors, and it then becomes the duty of the analysts to examine them, and to determine whether they conform to the requirements of the statutes relative to food and drug adulteration (Regulation 5).

The results of analysis are reported to the secretary, who in turn reports these results to the Board.

The analyst is required to reserve a portion of each sample, so that, if it proves to be adulterated, a sealed portion may be delivered to any person against whom a complaint is made, or to his attorney (Regulation 8).

The secretary has charge of the reports of analysts, and is authorized to cause complaints founded on such reports to be submitted to the courts for prosecution. He is also authorized, in case of a retailer, or any one not a manufacturer or producer, to issue a warning notice of the violation of the law, and of the offender's liability to prosecution upon repetition of the sale (Regulation 10).

Labelling. — The subject of the proper labelling of food products is one of considerable importance, since the label is usually intended to convey to the consumer certain information as to the character of the article to which it is attached. It very frequently happens that the analysis or examination of the article in question shows an entirely different composition from that which is stated upon the label. Such words as "high quality," "high grade," "excellent quality," "pure," "unadulterated," are often found attached to articles of the

most worthless character. The misuse of the words "compound," "compounded," "blended," "mixture," etc., has also often been referred to in these reports.

The following label is a sample of a misleading label, and was found attached to a jar of so-called quince preserve. It is only one of very many of a similar character.

HIGH GRADE PRESERVES.

Quince.

(Compounded.)

Fruit,	250
Corn syrup,	300
Granulated sugar,	250
Fruit juice,	200
Colored.	

The contents proved to be of a very low grade, and not of a high grade, as stated. The corn syrup (or glucose) which the jar contained was much greater in its percentage than the amount stated on the label, and the granulated sugar much less. The fruit juice consisted, as usual, of apple and not of quince. The real quince employed in making this compound had either been treated in some manner previously to the process of canning, or its genuine flavor had become very much impaired by the poor quality of the mixture in which it was preserved.

The following is another sample, in which the attempt to deceive is of another character: —

LEMON EXTRACT.

Alcohol,	535
Aqua,	450
Oil lemon,	15
Napthol color very slight.	

The use of the latin word signifying water is a clumsy fraud, and plainly intended to deceive. Moreover, the percentage of alcohol present was considerably less than that which is indicated on the label, and the water considerably more; and there was no oil of lemon.

The following label was printed upon a package of the Black Diamond brand of borax: —

ARCHIBALD AND LEWIS

BLACK DIAMOND.

REFINED

POWDERED

BORAX.

Office, 193 Front St., New York.

CAUTION.

"Avoid the many spurious imitations of our borax, with which the market is flooded, and which can only do harm to those who use them. See that our trade mark of a black diamond is on every package"

All of the packages bearing the foregoing label were found on analysis to be seriously adulterated with bicarbonate of soda.

Microscopical Examination of Food. — The term "analyst," as applied to the examination of articles of food or drugs, has a broader significance than that of chemist, since other analytical methods must necessarily be employed in examination than those which require a knowledge of chemistry alone. The food analyst should have, in addition to the technical knowledge essential to his work, a normal and healthy condition of all his five senses, and especially those of sight, smell, taste and feeling. As an aid to the sense of sight, the microscope is especially valuable for the examination of very many kinds of food which are sold in the powdered form, such as the spices, cereals and coffee, as well as lard and butter.

A prominent feature of the present report is the special paper prepared by Mr. Leach upon "Microscopical Examination of Foods for Adulteration." The illustrations accompanying this paper are all made from samples obtained in the ordinary course of food inspection, and were prepared in the laboratory of the Board. They will be found very instructive, as showing the actual appearances of the different kinds of spices, coffee and other articles when subjected to microscopic examination.

In the analyst's report of the present year further information may be found, in addition to that already published in earlier reports, upon the method of detecting artificial coloring matter in

milk. This practice is usually conducted for the purpose of concealing fraud. Nearly three-fourths of the whole number of samples of colored milk were found to be below the legal standard. These colored samples were found in the milk of ten cities and two large towns.

The following lists contain the names of cities and towns to which notices were sent in 1900 on account of adulterated articles which were deemed worthy of notification: —

Cities and Towns to which Notices were sent on Account of Adulterated Milk in 1900.

Adams,	7	Malden,	1
Attleborough,	4	Manchester,	1
Beverly,	2	Milford,	1
Boston,	14	Nantasket,	1
Brockton,	4	Nantucket,	2
Brookline,	1	Needham,	1
Cambridge,	4	New Bedford,	1
Chelsea,	23	Newburyport,	1
Cottage City,	5	Newton,	5
Dedham,	1	Pittsfield,	1
Everett,	2	Plymouth,	1
Fall River,	3	Quincy,	6
Fitchburg,	2	Revere,	5
Gloucester,	3	Salem,	4
Haverhill,	2	Stoughton,	4
Hyde Park,	5	Tisbury,	1
Lawrence,	8		
Leominster,	4	Total,	130

Cities and Towns to which Notices were sent on Account of Adulterated Articles of Food other than Milk.

Boston,	46	Malden,	2
Brookline,	1	Medford,	2
Cambridge,	9	New Bedford,	2
Chelsea,	4	Provincetown,	1
Clinton,	1	Rockport,	1
Cottage City,	3	Salem,	6
Edgartown,	1	Somerville,	11
Everett,	2	Springfield,	3
Fall River,	6	Stoneham,	1
Fitchburg,	1	Taunton,	1
Haverhill,	2	Woburn,	2
Lawrence,	5		
Lowell,	15	Total,	128

Cities and Towns to which Notices were sent on Account of Adulterated Drugs.

Adams,	2	Fall River,	4
Barre,	2	Lowell,	3
Boston,	1	North Adams,	3
Cambridge,	2		
Chelsea,	1	Total,	18

Prosecutions.

The following condensed summary is presented in accordance with the custom which has been followed in the reports of the past eight years.

The following table presents the same figures, with the addition of the data relating to the prosecutions conducted during the year ended Sept. 30, 1900: —

Number of Complaints entered in Court.

Year.	Food (not including Milk).	Drugs.	Milk.	Total.	Convictions.	Fines Imposed.
1883,	–	5	4	9	8	–*
1884,	2	1	45	48	44	–*
1885,†	50	1	68	119	103	–*
1886,‡	10	–	10	20	19	–*
1887,	30	–	34	64	60	–*
1888,	22	–	43	65	61	$2,042 00
1889,	74	–	66	140	124	3,889 00
1890,	78	–	24	102	96	3,919 00
1891,	96	5	49	150	135	2,668 00
1892,	52	12	72	136	123	3,661 70
1893,	26	3	67	96	92	2,476 00
1894,	14	–	76	90	77	2,625 00
1895,	13	11	68	92	86	2,895 30
1896,	7	–	68	75	74	2,812 20
1897,	13	1	51	65	64	2,756 60
1898,	10	–	54	64	62	2,060 98
1899,	19	2	26	47	45	1,432 66
1900,	45	5	44	94	89	1,890 70
Totals,	561	46	869	1,476	1,362	$34,129 14

* No record kept. † To May 1, 1886. ‡ Four months only.

Ratio of convictions to complaints, 92.3 per cent.

Note. — All complaints entered before May 1, 1886, were under the direction of the Board of Health, Lunacy and Charity, and all after that date were under the direction of the State Board of Health.

The number of prosecutions made against offenders during the year was 94, and the number of convictions 89.

The following report was sent to the Legislature Jan. 7, 1901: —

OFFICE OF THE STATE BOARD OF HEALTH,
STATE HOUSE, BOSTON, Jan. 7, 1901.

To the Honorable Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The following summary is made in compliance with the provisions of chapter 289, section 2, of the Acts of 1884, requiring the State Board of Health to "report annually to the Legislature the number of prosecutions made under chapter 263 of the Acts of 1882, and an itemized account of all money expended in carrying out the provisions thereof."

The whole number of prosecutions made by authority of the Board against offenders, under the provisions of the food and drug acts, for the year ended Sept. 30, 1900, was 94.

The cities and towns in which the articles were sold, and in respect to which complaints were entered in court, the character of the articles found to be adulterated, or fraudulently sold, the dates of the trials, and their results, are presented in the following table: —

MILK AND MILK PRODUCTS.

For Fraudulent Sales of Milk.

PLACE.	DATE.	RESULT.
Boston,	April 17, 1900,	Convicted.
Boston,	April 17, 1900,	Convicted.
Boston,	June 6, 1900,	Convicted.
Fall River,	Oct. 19, 1899,	Discharged.
Fall River,	Oct. 19, 1899,	Discharged.
Lawrence,	June 30, 1900,	Convicted.
Haverhill,	July 10, 1900,	Convicted.
Haverhill,	July 10, 1900,	Convicted.
Haverhill,	Sept. 29, 1900,	Convicted.
Haverhill,	Sept. 29, 1900,	Convicted.
Gloucester,	Oct. 2, 1899,	Convicted.
Gloucester,	Jan. 17, 1900,	Convicted.
Gloucester,	Aug. 4, 1900,	Convicted.
Gloucester,	Aug. 4, 1900,	Convicted.
Gloucester,	Sept. 15, 1900,	Convicted.
Gloucester,	Sept. 15, 1900,	Convicted.
Cambridge,	Jan. 2, 1900,	Convicted.
New Bedford,	March 28, 1900,	Convicted.
Springfield,	March 9, 1900,	Convicted.
Chelsea,	Dec. 27, 1899,	Discharged.
Chelsea,	Dec. 27, 1899,	Discharged.
Chelsea,	Dec. 27, 1899,	Discharged.
Salem,	Aug. 22, 1900,	Convicted.

MILK AND MILK PRODUCTS — Concluded.

For Fraudulent Sales of Milk — Concluded.

Place.	Date.	Result.
Newton,	June 20, 1900,	Convicted.
Newton,	Aug. 13, 1900,	Convicted.
Everett,	Aug. 29, 1900,	Convicted.
Medford,	Oct. 4, 1899,	Convicted.
Beverly,	Feb. 16, 1900,	Convicted.
Stoughton,	Oct. 7, 1899,	Convicted.
Barre,	Nov. 22, 1899,	Convicted.
Danvers,	Dec. 15, 1899,	Convicted.
Danvers,	Dec. 15, 1899,	Convicted.
Dedham,	Dec. 29, 1899,	Convicted.
Dedham,	Jan. 4, 1900,	Convicted.
Dedham,	Sept. 27, 1900,	Convicted.
Westborough,	April 6, 1900,	Convicted.
Northborough,	April 12, 1900,	Convicted.
Northborough,	April 12, 1900,	Convicted.
Sudbury,	April 14, 1900,	Convicted.
Lincoln,	July 3, 1900,	Convicted.
Adams,	July 23, 1900,	Convicted.
Bedford,	Aug. 29, 1900,	Convicted.
Canton,	Aug. 7, 1900,	Convicted.
Cottage City,	Sept. 22, 1900,	Convicted.

Butter (Oleomargarine).

Wayland,	May 16, 1900,	Convicted.

Cream.

North Adams,	July 20, 1900,	Convicted.
North Adams,	July 20, 1900,	Convicted.

MOLASSES.

Gloucester,	Sept. 20, 1900,	Convicted.
Nantucket,	Oct. 4, 1899,	Convicted.
Nantucket,	Sept. 6, 1900,	Convicted.
Nantucket,	Sept. 6, 1900,	Convicted.

MAPLE SYRUP.

Lowell,	Jan. 31, 1900,	Convicted.
Lowell,	Jan. 31, 1900,	Convicted.

HONEY.

Boston,	Dec. 28, 1899,	Convicted.
Lowell,	Jan. 23, 1900,	Convicted.
Lowell,	Jan. 23, 1900,	Convicted.
Boston,	Jan. 30, 1900,	Convicted.
Wellesley,	July 3, 1900,	Convicted.

Vinegar.

Place.	Date.	Result.
Boston,	May 29, 1900,	Convicted.
Nantucket,	Sept. 6, 1900,	Convicted.

Preserves.

Ayer,	Feb. 19, 1900,	Convicted.

Olive Oil.

Lowell,	March 15, 1900,	Convicted.

Coffee.

North Adams,	Aug. 16, 1900,	Convicted.

Canned Peas.

Chelsea,	Oct. 20, 1899,	Convicted.
Chelsea,	Nov. 6, 1899,	Convicted.
Malden,	Nov. 11, 1899,	Convicted.
Malden,	Nov. 22, 1899,	Convicted.
Lowell,	Jan. 11, 1900,	Convicted.
Lowell,	Jan. 11, 1900,	Convicted.
Lowell,	Jan. 11, 1900,	Convicted.
Lowell,	Jan. 11, 1900,	Convicted.
Lowell,	Jan. 12, 1900,	Convicted.
Lowell,	Jan. 12, 1900,	Convicted.

Brandy Drops.

Lowell,	June 12, 1900,	Convicted.
Lowell,	June 12, 1900,	Convicted.
Lynn,	June 25, 1900,	Convicted.
Lynn,	June 25, 1900,	Convicted.
Malden,	June 26, 1900,	Convicted.
Malden,	June 26, 1900,	Convicted.
Medford,	June 26, 1900,	Convicted.
New Bedford,	June 27, 1900,	Convicted.
Fall River,	July 6, 1900,	Convicted.
North Adams,	Aug. 16, 1900,	Convicted.
North Adams,	Aug. 16, 1900,	Convicted.
North Adams,	Aug. 16, 1900,	Convicted.
North Adams,	Aug. 16, 1900,	Convicted.
North Adams,	Aug. 16, 1900,	Convicted.
Clinton,	June 29, 1900,	Convicted.
Clinton,	June 29, 1900,	Convicted.

Drugs.

Precipitated Sulphur.

Lowell,	Oct. 17, 1899,	Convicted.

DRUGS — Concluded.

Tincture of Iodine.

PLACE.	DATE.	RESULT.
Lowell,	Oct. 20, 1899,	Convicted.
Clinton,	June 29, 1900,	Convicted.

Tincture of Opium.

Lowell,	June 9, 1900,	Convicted.

Glycerine.

Clinton,	June 29, 1900,	Convicted.

Complaints entered in court under the provisions of acts relating to —

Milk,	44
Butter,	1
Other articles of food,	44
Drugs,	5
Total,	94

SUMMARY.

The whole number of complaints entered by the State Board of Health during the year ended Sept. 30, 1900, in the courts of the Commonwealth, against parties for violation of the statutes relating to food and drug inspection, was 94. In 89, or 94.7 per cent. of these, the parties were convicted; 5 were discharged.

Of the whole number, 44 were for violation of the statutes relating to the adulteration of milk and milk products, and of this number 39 resulted in conviction. The greater number of these were for violation of the statutes providing that milk offered for sale shall be of good standard quality. In 7 of the foregoing cases the complaints were for sales of milk containing coloring matter.

All of the parties against whom complaints were entered in the courts for fraudulent sales of other kinds of food were convicted. The articles of food and drugs with reference to which these complaints were made were as follows: —

Butter, 1 case; cream, 2 cases; molasses, 4 cases; maple syrup, 2 cases; honey, 5 cases; vinegar, 2 cases; preserves, 1 case; olive oil, 1 case; canned peas, 10 cases; brandy drops, 16 cases; drugs, 5 cases.

The samples of cream referred to in the foregoing list were adulterated with gelatine.

The samples of molasses for which complaints were entered in court contained in one instance 70 per cent., in another 75 per cent. and in another 90 per cent. of glucose.

The sales of canned peas, on account of which several complaints were entered in the fall and winter of 1899–1900, were in violation of chapter 344 of the Acts of 1897, article 5, which provides that "All canned articles of food prepared from dried products which have been soaked before canning shall be plainly marked by an adhesive label, having on its face the word 'Soaked' in letters not less in size than two-line pica, of legible type."

The complaints for sales of brandy drops were made on account of violation of the statutes of 1891, chapter 333, which provides that "No person shall sell to any child under sixteen years of age any candy or other article inclosing liquid or syrup containing more than one per cent. of alcohol."

There has been during the past year or more an unusual increase in the amount of adulteration of jellies, jams and preserves, the adulteration consisting chiefly in the substitution of cheaper kinds of fruit, such as the refuse portions of apples, to which is added glucose instead of cane sugar, together with aniline dyes to imitate the color of natural fruit.

The following provisions of recently enacted food laws of the State are herewith published for general information, since they are subject to frequent violation, either wilfully, or through the ignorance of the offending parties: —

[Acts of 1897, Chapter 344, Section 3.]

Section 3. An article shall be deemed to be adulterated within the meaning of this act in the case of food: — 1. If any substance or substances have been mixed with it, so as to lower or depreciate or injuriously affect its quality, strength or purity. 2. If any inferior or cheaper substance or substances have been substituted wholly or in part for it. 3. If any valuable or necessary constituents or ingredients have been wholly or in part taken from it. 4. If it is in imitation of or is sold under the name of another article. 5. If it consists wholly or in part of a diseased, decomposed, putrid, tainted or rotten animal or vegetable substance or article, whether manufactured or not, or, in the case of milk, if it is produced from a diseased animal. 6. If it is colored, coated, polished or powdered in such a manner as to conceal its damaged or inferior condition, or if by any means it is made to appear better, or of greater value, than it really is. 7. If it contains any added substance or ingredient which is poisonous or injurious to health: *provided*, that the provisions of this act

shall not apply to mixtures or compounds recognized as ordinary articles or ingredients of articles of food, if every package sold or offered for sale is distinctly labelled as a mixture or compound, with the name and per cent. of each ingredient therein, and if such mixtures or compounds are not injurious to health.

The following statute, as amended in 1899 (by chapter 223 of the Acts of that year), presents the standard of milk in Massachusetts at the date of publishing this report: —

[Acts of 1899, Chapter 223.]

In all prosecutions under this chapter, if the milk is shown upon analysis to contain less than thirteen per cent. of milk solids, or to contain less than nine and three-tenths per cent. of milk solids exclusive of fats, or to contain less than three and seven-tenths per cent. of fat, it shall be deemed for the purposes of this act to be not of good standard quality, except during the months of April, May, June, July, August and September, when milk containing less than twelve per cent. of milk solids, or less than nine per cent. of milk solids exclusive of fat, or less than three per cent. of fat, shall be deemed to be not of good standard quality.

The following statute, relating to the inspection of milk, was enacted last year: —

[Acts of 1900, Chapter 300.]

An Act relative to the Adulteration of Milk.

Be it enacted, etc., as follows:

Section 1. Section five of chapter fifty-seven of the Public Statutes, as amended by section two of chapter three hundred and eighteen of the acts of the year eighteen hundred and eighty-six, is hereby further amended by striking out the whole of said section and inserting in place thereof the following: *Section 5.* Whoever by himself or by his servant or agent, or as the servant or agent of another person, sells, exchanges, or delivers, or has in his custody or possession with intent to sell or exchange, or exposes or offers for sale or exchange, adulterated milk, or milk to which water or any foreign substance has been added, or milk produced from cows fed on the refuse of distilleries, or from sick or diseased cows, or, as pure milk, milk from which the cream or any part thereof has been removed, shall for a first offence be punished by fine of not less than fifty nor more than two hundred dollars; for a second offence by fine of not less than one hundred nor more than three hundred dollars; and for a subsequent offence by fine of fifty dollars and by imprisonment in the house of correction for not less than sixty nor more than ninety days.

Section 2. Section six of chapter fifty-seven of the Public Statutes is hereby amended by striking out the whole of said section and inserting in

place thereof the following: *Section 6.* Whoever by himself or by his servant or agent, or as the servant or agent of any other person, sells, exchanges, or delivers, or has in his custody or possession with intent to sell or exchange milk not of good standard quality, shall for a first offence be punished by fine not exceeding fifty dollars; for a second offence by fine of not less than one hundred dollars nor more than two hundred dollars; and for a subsequent offence by fine of fifty dollars and by imprisonment in the house of correction for not less than sixty nor more than ninety days. [*Approved May 8, 1900.*

In consequence of the provisions of section two of the foregoing statute, the amount of money turned into the local treasuries has been materially diminished, since the penalty for selling milk "not of good standard quality," which before the enactment of this law was in no case less than $50, was so altered by its enactment as to allow a fine of any sum, not exceeding $50, at the discretion of the court.

The whole number of samples of food and drugs examined in this department since the beginning of work in 1883 was 117,515, and the number of complaints entered in court was 1,476. The average cost per sample for collection, analysis and other work has been reduced from $2.26 in 1883 to $1.09 in 1900.

The following list presents the total solids in each of the samples of milk upon which complaints were founded, so far as records of the same were kept: —

6.50	9.49	10.40	10.92	11.40
7.59	9.69	10.44	10.97	11.46
9.10	9.69	10.45	11.10	11.48
9.17	9.70	10.48	11.13	11.60
9.19	9.80	10.50	11.27	11.74
9.45	10.15	10.51	11.28	11.80
9.46	10.27	10.75	11.37	
9.49	10.33	10.80	11.40	

The total number of samples of food and drugs examined during the year was as follows: —

Milk,	6,277
Other articles of food,	3,132
Drugs,	758
Total,	10,167

Total expenses of collection, examination and prosecution,	$11,108 73
Average expense per sample collected,	1 09

FINES.

The amount of fines paid into the treasuries of counties, cities and towns, under the provisions of the general and special laws relative to the inspection of food and drugs, was as follows: —

Fines paid for the Violation of the Food and Drug Acts upon Cases entered for the Year ending Sept. 30, 1900.

Under the provisions of the laws relating to milk and milk products,	$1,316 20
Under the provisions of the laws relating to other articles of food,	487 50
Under the provisions of the laws relating to drugs,	87 00
Total,	$1,890 70

The total amount of fines imposed since the beginning of the enforcement of the general food acts to Sept. 30, 1900, was $35,129.14.

EXPENDITURES

Under the Provisions of the Food and Drug Acts during the Year ending Sept. 30, 1900.

	For the Enforcement of the Statutes relating to Food and Drug Inspection.	
	Relative to Milk and Milk Products.	Relative to Other Kinds of Food and Drugs.
Salaries of analysts,	$2,640 00	$1,760 00
Salaries of inspectors,	2,400 00	1,600 00
Travelling expenses and purchase of samples,	1,080 00	720 00
Apparatus and chemicals,	175 80	100 00
Printing,	6 00	3 11
Special investigations,	20 00	15 00
Extra services for inspection,	150 00	92 00
Services (cleaning laboratory),	70 00	33 51
Express,	4 93	–
Sundry laboratory supplies,	99 56	30 41
Books,	50 00	25 20
Stationery,	15 00	5 70
Extra services (stenographer),	12 51	–
	$6,723 80	$4,384 93
		6,723 80
Total,		$11,108 73

REPORT OF THE ANALYST.

By Albert E. Leach.

REPORT OF THE ANALYST.

By Albert E. Leach.

Dr. S. W. Abbott, *Secretary of the State Board of Health.*

Dear Sir : — I herewith submit my report on the analysis of food and drugs for the year ending Sept. 30, 1900.

Milk.

Six thousand, one hundred and thirty-seven samples of milk were collected and examined during the year, of which 1,799, or 23.6 per cent. were below the standard. This shows the lowest ratio of adulteration in any year since the food and drug act has been in force.

In the summer of 1900 the new law went into effect, under the terms of which a distinction is made between milk actually adulterated by reason of the fraudulent addition of water or of foreign substances, and milk simply below the standard fixed by law. Prior to the date of this act, as is well known, milk below the standard was virtually considered in the same category as adulterated milk, in that a minimum fine of $50 was the penalty fixed in either case. Now, according to the new law, it becomes incumbent upon the analyst to show to the satisfaction of the court, in case of milk low in solids, whether or not the milk has been fraudulently watered, for the reason that, if the milk is actually adulterated, the minimum fine is $50, while for milk simply below the standard it may be less, but not more than $50.

In case of excess of water, the analyst is obliged to judge whether or not the milk has been actually adulterated by a careful study of the relation between the percentage of total solids, fat and solids not fat. If both the total solids and the solids not fat are abnormally low, and the proportion of fat to solids not fat about the same as, or higher than, in a normal milk, it is generally safe to assume that the sample has been watered. If both the total solids and the fat are well below the standard and the solids not fat nearly normal,

then the milk has undoubtedly been skimmed. If, in the third place, the total solids and the solids not fat are proportionally reduced below the standard, while the ratio of fat to solids not fat is abnormally small, it is safe to adjudge the milk to be low by reason of both skimming and watering.

It is difficult to place the minimum figure for total solids below which a milk sample may safely be pronounced by the analyst as fraudulently watered after having been drawn from the cow. Nearly 900 samples of milk of known purity from various breeds of cow, milked in the presence of an inspector, have been analyzed by this department, extending over a period of fifteen years, and among these are many samples from Holstein cows, a breed that more than any other is open to the charge of sometimes giving milk below the legal standard. It is extremely rare that any of these samples of known purity have been found with total solids as low as 11 per cent., though there are instances where the total solids have run as low as 10 per cent. It is safe to assume that, in the few cases on record showing less than 10.75 per cent. of total solids, either there was something decidedly abnormal about the health of the cow, or through some accident the cow was only partially milked, it being a well-known fact that the last fraction of the milking, commonly known as the "strippings," includes the larger percentage of fat. It is nearly always safe to condemn a milk that stands below 10.75 per cent. in total solids as fraudulently watered, if at the same time it has a proportionately high per cent. of fat.* The average total solids of 800 samples of milk of known purity analyzed by the Board up to and including the year 1890 amounted to about 13¼ per cent. It is rare indeed to find a herd of ten or more well-fed cows of different breeds in which the average milk of the herd falls below 12½ per cent. of solids.

Methods of analysis of milk employed in this laboratory were given quite fully in the preceding report of the Board.

Additional Notes on Artificial Coloring Matter in Milk. — It is sometimes necessary to examine a sample of sour milk for foreign coloring matter. If the milk is actually curdled, it is unnecessary

* It is a curious fact that among the samples of known purity analyzed by the Board both the lowest and highest total solids on record came from a Holstein cow; the lowest recorded total solids in a "known purity" milk being 9.96 per cent. (seventh annual report of Massachusetts State Board of Health, Lunacy and Charity, page 160), and the highest being 17.06 per cent. (twenty-second annual report of the Massachusetts State Board of Health, page 405).

to treat with acetic acid, as in the general scheme for detection of color in milk, outlined in the previous report. A sample of the milk is shaken directly with ether and the whole poured into a large tube and whirled in an electrical centrifuge of the Robinson type, the ether solution being then decanted and examined for the annatto, while the curd is examined for aniline orange, caramel, etc.

*Lythgoe's Modified Method for the Detection of Aniline Orange in Milk.** — Hermann C. Lythgoe of this laboratory has found that, in testing a sample of milk for formic aldehyde with an equal volume of strong hydrochloric acid containing ferric chloride,† on mixing the cold acid with the milk, the resulting curd was of an intense pink color, and that, upon further examination by the writer's regular method,‡ the sample was found to contain aniline orange. This suggested the following quick method for the detection of aniline orange in milk: —

About 15 cubic centimeters of milk are placed in a porcelain casserole, and about the same quantity of hydrochloric acid (specific gravity, 1.20) is added, gently shaking the casserole to cause thorough mixing and to break up the curd into rather coarse lumps. If the milk contains aniline orange, the curd will be colored pink; while if it be free from the color, the curd will remain white or yellowish, according to the natural color of the milk. If it is desired to test the milk for formic aldehyde, this same solution may be boiled after the usual addition of a drop of ferric chloride solution, and if the aldehyde is present, the usual purple color will appear. Both adulterants may thus be tested for simultaneously, the presence of neither substance affecting the delicacy of the test for the other.

Commercial hydrochloric acid, to which ferric chloride has been added may be used, provided that the solution is not too yellow. It has been the custom in this department to add 5 cubic centimeters of a 10 per cent. solution of ferric chloride to 2 litres of hydrochloric acid, and to use this solution in testing for aniline orange and formic aldehyde in milk.

Sixty-seven samples of milk, or over 1 per cent. of all the samples examined during the year, were found to be adulterated by the addition of foreign coloring matter. Of these, 20 contained annatto,

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* Journal American Chemical Society, XXII., page 813.

† Twenty-ninth annual report of Massachusetts State Board of Health, 1897, page 558.

‡ A. E. Leach, Journal American Chemical Society, XX., page 207.

all of which were below the standard of total solids; 43 contained aniline orange, 19 of these being above the standard and 24 being below; while 4 were colored with caramel, all below the standard; 1 sample of milk was found to contain both caramel and annatto.

Samples of colored milk were found in Beverly, Boston, Chelsea, Danvers, Everett, Gloucester, New Bedford, Newton, North Attleborough, Salem, Somerville and Woburn.

In all, 134 samples of milk were found to be adulterated by the actual addition of a foreign substance. Of these, 64 were above the legal standard of total solids and 70 were below.

	Above Standard.	Below Standard.	Total.
Number samples containing aniline orange,	19	24	43
Number samples containing annatto,	–	20	20
Number samples containing caramel,	1	3	4
Number samples containing formaldehyde,	39	22	61
Number samples containing boracic acid,	5	1	6
Total number samples containing foreign matter,	64	70	134

The following tables of statistics show in the usual manner the distribution throughout the State of the samples of milk collected during the year: —

Milk from Cities.

Cities.	Total Samples Collected.	Above Standard.	Below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Colored Samples.	Number of Preserved Samples.
Boston,	456	286	170	37.3	9.69	–	4	2
Brockton,	176	127	49	27.8	10.70	1	–	2
Cambridge,	367	240	127	34.6	9.17	–	–	1
Chelsea,	313	167	146	46.7	8.80	–	9	7
Everett,	150	123	27	18.0	10.63	–	5	9
Fall River,	122	100	22	18.0	9.60	–	–	8
Fitchburg,	102	71	31	30.8	9.30	1	–	–
Gloucester,	204	162	42	20.6	10.63	–	2	–
Haverhill,	216	164	52	24.0	9.19	2	–	–
Lawrence,	154	110	44	28.5	8.87	5	–	–
Malden,	179	124	55	30.7	11.08	–	–	–
Marlborough,	95	75	20	21.0	9.36	4	–	–
Medford,	158	120	38	24.0	9.48	–	–	–
New Bedford,	90	52	38	42.2	10.34	–	16	–
Newburyport,	122	91	31	25.4	9.69	1	–	–
Newton,	165	127	38	23.0	9.65	1	1	–
North Adams,	42	37	5	11.8	9.40	–	–	4
Quincy,	104	71	33	31.7	9.73	3	–	–
Salem,	205	153	52	25.4	10.70	–	5	6
Somerville,	539	350	189	33.2	9.65	–	12	12
Taunton,	51	48	3	5.9	9.22	2	–	–
Waltham,	118	94	24	20.3	11.08	–	–	–
Woburn,	109	68	41	37.6	9.65	–	1	2
Worcester,	137	102	35	25.7	11.40	–	–	–
Totals,	4,374	3,054	1,320	30.2	8.80	20	55	53

Milk from Towns.

TOWNS.	Total Samples Collected.	Above Standard.	Below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Colored Samples.	Number of Preserved Samples.
Adams, . . .	26	17	9	34.0	8.94	–	–	–
Andover, . .	2	2	–	0.0	12.20	–	–	–
Ashland, . .	2	–	2	100.0	12.75	–	–	–
Attleborough, .	53	38	15	28.3	9.06	2	1	2
Beverly, . .	46	36	10	21.7	10.65	1	2	1
Brookline, . .	134	102	32	24.6	11.75	–	–	–
Canton, . . .	24	21	3	12.5	7.59	–	–	–
Clinton, . . .	44	27	17	38.6	9.60	2	–	–
Cottage City, .	59	45	14	23.7	11.23	–	–	–
Danvers, . .	19	9	10	52.6	10.92	–	5	–
Dedham, . .	69	53	16	23.2	10.60	1	–	–
Duxbury, . .	6	6	–	0.0	13.00	–	–	–
Framingham, .	15	14	1	6.7	12.70	–	–	–
Hopkinton, . .	5	5	–	0.0	13.82	–	–	–
Hudson, . .	1	1	–	0.0	12.50	–	–	–
Hull, . . .	27	26	1	3.7	11.60	–	–	–
Hyde Park, . .	120	74	46	38.4	11.11	1	–	5
Leominster, . .	22	18	4	18.2	8.93	2	–	–
Manchester, . .	5	5	0	0.0	12.70	–	–	2
Milford, . .	34	28	6	17.7	10.02	1	–	–
Nantucket, . .	27	23	4	14.8	10.34	–	–	–
Natick, . . .	41	32	9	21.9	9.90	3	–	–
Peabody, . .	18	9	9	50.0	11.14	–	1	–
Plymouth, . .	39	34	5	12.9	10.90	–	–	–
Provincetown, .	20	20	–	0.0	12.00	–	–	–
Reading, . .	6	6	–	0.0	12.40	–	–	–
Rockport, . .	7	6	1	14.3	11.97	–	–	–
Revere, . . .	152	116	36	23.7	10.72	–	–	–
Salisbury, . .	15	12	3	20.0	10.80	–	–	–
Stoneham, . .	45	35	10	22.2	10.16	2	–	–
Stoughton, . .	130	91	39	30.0	10.70	–	–	–
Wakefield, . .	3	3	0	0.0	12.00	–	–	–
Watertown, . .	79	64	15	19.0	9.44	–	–	3
Wareham, . .	14	14	–	0.0	12.00	–	–	–
Westborough, .	18	16	2	11.1	10.15	2	–	–
Westfield, . .	1	1	–	0.0	14.28	–	–	–
Winchester, . .	56	49	7	12.4	12.28	–	–	–
Winchendon, .	1	–	1	100.0	3.90	–	–	–
Winthrop, . .	72	61	11	15.2	11.70	–	–	–
Totals, . .	1,457	1,119	338	23.0	3.90	17	9	13

Milk from Suspected Producers.

LOCALITY.	Total Samples Collected.	Above Standard.	Below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.
Andover, ...	8	4	4	50.0	10.52
Bedford, ...	22	18	4	18.2	10.80
Billerica, ...	16	9	7	43.8	11.20
Dedham, ...	31	4	27	87.1	11.00
Dover, ...	5	–	5	100.0	11.70
Lincoln, ...	20	10	10	50.0	10.45
Medfield, ...	14	9	5	35.7	11.89
Needham, ...	76	44	32	42.1	11.04
Northborough, ...	27	–	27	100.0	10.51
Sudbury, ...	8	–	8	100.0	10.20
Waltham, ...	11	10	1	10.0	11.65
Wayland, ...	15	9	6	40.0	12.25
Westborough, ...	2	–	2	100.0	11.27
Weston, ...	22	22	–	0.0	12.42
Totals, ...	277	139	138	50.0	10.20

Summary of Milk Statistics.

	Total Samples Collected.	Above Standard.	Below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Colored Samples.	Number of Preserved Samples.
Cities, ...	4,374	3,054	1,320	30.2	8.80	20	55	53
Towns, . . .	1,457	1,119	338	23.0	3.90	17	9	13
Suspected producers,	277	139	138	50.0	10.20	-	-	-
Miscellaneous, . .	29	26	3	10.4	9.67	-	1	-
Totals, . . .	6,137	4,338	1,799	26.3	3.90	37	65	68

The twelve monthly reports presented during the year are thus summarized: —

Quality of Milk by Months.

	October.	November.	December	January.	February.	March.	April.	May.	June.	July.	August.	September.	Total.
Number having more than 15 per cent. of total solids, .	29	16	28	31	29	24	19	14	13	20	29	14	237
Number having between 14 and 15 per cent. of total solids.	60	53	58	47	51	60	35	21	21	28	41	39	504
Number having between 13 and 14 per cent. of total solids.	199	207	220	196	196	179	173	122	143	111	141	120	2,007
Number having between 12 and 13 per cent. of total solids.	176	195	184	163	156	202	268	289	226	221	258	262	2,600
Number having between 11 and 12 per cent. of total solids.	15	40	39	18	30	59	35	49	47	52	66	74	524
Number having between 10 and 11 per cent. of total solids.	12	11	8	12	4	18	13	14	13	14	25	12	156
Number having between 9 and 10 per cent. of total solids.	3	1	4	5	10	3	11	2	10	4	5	5	63
Number having between 8 and 9 per cent. of total solids.	1	-	-	-	-	-	-	-	2	1	-	-	4
Number having less than 8 per cent. of total solids, .	-	1	-	-	1	-	-	-	-	1	-	-	3
Number of samples of skimmed milk above the standard.	4	-	1	4	2	2	5	1	5	1	-	2	27
Number of samples of skimmed milk below the standard.	1	-	3	1	2	1	3	1	4	1	2	1	20

The milk standards have been so frequently changed of late years by legislative enactment that it is difficult to see from the above statistics whether or not there is any actual improvement in the quality of the milk collected and examined. For this reason the following table has been prepared, based on the standard that prevailed from 1886 to 1895 inclusive, in which the 13 per cent. standard was legal throughout the year excepting in May and June, when the standard was 12 per cent., thus placing, for purposes of comparison, the statistics of the present year on the same basis as those that were in

force for so many years. According to this assumed standard, the ratio of adulteration would be 45.7 per cent.

Quality of Milk by Months, assuming the Standard of 1886.

	Above Assumed Standard.	Below Assumed Standard.	Total.
October,	292	203	495
November,	276	248	524
December,	307	234	541
January,	278	194	472
February,	278	199	477
March,	265	280	542
April,	232	322	554
May,	447	64	511
June,	408	67	475
July,	160	292	452
August,	211	354	565
September,	175	351	526
Total,	3,329	2,808	6,137
Per cent. below assumed standard,	–	45.7	–

Cream. — Ten samples of cream were examined, of which 3 were found to contain a new adulterant, and the department was fortunate in procuring a sample of the adulterant in the form used. This on examination was found to be a mixture of borax, boracic acid and gelatine.

Gelatine is very readily detected in cream by the method of A. W. Stokes.* A solution of acid nitrate of mercury is prepared by dissolving mercury in twice its weight of nitric acid (specific gravity, 1.42), and diluting this solution to 25 times its bulk by the addition of water. Ten cubic centimeters of milk or cream to be examined is diluted with an equal volume of the acid nitrate solution, and the mixture shaken, after which 20 cubic centimeters of water are added. The liquid is again shaken, allowed to stand for five minutes and filtered. To a portion of the filtrate in a test tube an equal bulk of a saturated aqueous solution of picric acid is added. A yellow precipitate will be produced in the presence of any con-

* Allen Com. Organic Analysis, vol. 4, page 181, second edition.

siderable amount of gelatine. In the absence of gelatine, the filtrate thus treated will be perfectly clear. If much gelatine is used, the filtrate will be opalescent.

Condensed Milk and Evaporated Cream. — Forty-two brands of condensed milk were examined during the year, none of which was sufficiently low in fat content to be considered adulterated by skimming. The results of the analyses are shown in the following table, arranged in the order of the fat: —

Brand.	Total Solids.	Water.	Milk Solids.	Cane Sugar.	Milk Sugar.	Protein.	Fat.	Ash.	Fat in Original Milk.
Milk Maid,	76.56	23.44	34.39	42.17	13.40	7.67	11.40	1.92	4.21
Eclipse,	75.46	24.25	26.58	48.88	6.09	7.91	10.95	1.63	6.51
Premium,	74.47	25.53	30.25	44.22	9.58	8.11	10.80	1.76	5.30
Ensign,	74.81	25.19	35.81	39.00	14.57	8.92	10.71	1.61	3.97
Rose,	76.81	23.19	31.02	45.79	11.17	7.41	10.50	1.94	4.77
Rose,	74.83	25.17	32.98	41.85	11.97	8.85	10.44	1.72	4.33
Connor,	71.52	28.48	28.99	42.53	9.05	7.85	10.44	1.65	5.22
Connor,	69.59	30.41	26.64	42.95	6.44	8.22	10.44	1.54	5.97
Tip Top,	73.50	26.50	33.76	39.74	12.50	9.02	10.44	1.80	4.16
Hero,	70.51	29.49	29.13	41.38	8.37	8.93	10.33	1.50	5.09
Connor,	66.96	33.04	27.10	39.86	6.70	8.57	10.26	1.57	5.62
Challenge,	76.56	23.44	29.08	47.48	9.75	7.43	10.20	1.70	5.08
Extra,	78.60	21.40	33.79	44.81	12.88	8.85	10.20	1.86	4.08
Hero,	77.04	22.96	31.10	45.94	9.58	9.92	9.95	1.65	4.42
Nickel,	75.07	24.93	32.81	42.26	11.97	9.12	9.90	1.82	4.02
Tip Top,	81.42	18.58	31.56	49.86	11.97	7.82	9.90	1.87	4.05
Nickel,	74.31	25.69	34.56	39.75	13.96	8.95	9.90	1.75	3.75
Hires,	69.96	30.04	28.71	41.25	9.10	8.24	9.81	1.56	4.86
Vermont,	73.71	26.29	27.98	45.73	7.98	8.59	9.80	1.61	4.90
Eagle,	77.20	22.80	31.16	46.06	11.17	8.51	9.75	1.73	4.24
Pine Tree,	73.11	26.89	28.77	44.34	8.87	8.49	9.75	1.66	4.78
Champlain,	72.37	27.63	30.82	41.55	10.80	8.69	9.72	1.61	4.28
Ajax,	71.17	28.83	28.06	43.11	8.54	8.32	9.72	1.48	4.96
Dairy,	72.63	27.37	29.21	43.42	10.15	7.72	9.66	1.68	4.60
Maine,	69.94	30.06	27.95	41.99	9.30	7.41	9.60	1.64	4.41
Connor,	72.96	27.04	34.00	38.96	14.57	8.22	9.45	1.76	3.60
Pine Tree,	73.05	26.95	30.44	42.61	12.50	6.93	9.45	1.56	4.29
Challenge,	74.72	25.28	28.82	45.90	10.15	7.58	9.45	1.64	4.62
Advanced,	71.32	28.68	30.87	40.45	12.88	7.24	9.18	1.57	4.13
Lone Star,	74.62	25.38	29.52	45.10	11.17	7.76	9.00	1.68	4.09
Coin,	74.02	25.98	30.79	43.23	11.97	8.11	9.00	1.71	3.85
Sachem,	73.19	26.81	28.93	44.26	8.87	9.27	9.00	1.79	4.43
Champlain,	73.75	26.25	31.10	42.65	11.97	8.53	9.00	1.60	3.96
Winner,	70.24	29.76	28.23	42.10	9.58	8.15	9.00	1.50	4.34
Challenge,	71.02	28.98	28.78	42.24	10.15	8.16	9.00	1.47	4.23
Grandmother's,	77.00	23.00	29.64	47.36	9.58	9.65	8.67	1.74	3.85
Defiance,	66.76	33.24	26.45	40.31	8.37	8.17	8.46	1.45	4.43
Burlington,	70.31	29.69	24.81	45.50	7.12	7.86	8.28	1.65	4.60
Tulip,	70.31	29.69	33.14	37.17	15.23	8.16	8.25	1.50	3.24
Rustic,	73.43	26.57	29.61	43.82	11.97	7.97	8.10	1.57	3.51
Lion,	74.65	25.35	30.61	44.04	12.50	7.86	7.65	1.60	3.11
Banquet,	71.59	28.41	32.50	39.09	14.57	8.76	7.56	1.61	2.82

Two samples of condensed milk not included in the above table were examined for tyrotoxicon, both samples being sufficiently decomposed to cause swelling of the heads of the cans. No tyrotoxicon was found.

Four samples of evaporated cream were analyzed, as follows: —

Brand.	Total Solids.	Water.	Milk Sugar.	Protein.	Fat.	Ash.	Fat in Original Milk.	Grammes of Tin in Contents of Can.
Borden's Peerless,	32.55	67.45	11.97	9.06	9.45	1.61	3.76	0.0079
Highland,	31.45	68.55	10.15	10.03	9.60	1.54	4.00	0.0189
Borden's Peerless,	32.98	67.02	11.55	10.27	9.09	1.72	3.62	–
Imperial,	33.98	66.02	11.17	6.64	13.80	1.61	6.34	0.0040

Three of the evaporated cream samples were examined for tin salts, which were found present in all of them. Samples of condensed milk were also examined for tin, but with negative results. The acidity of the evaporated cream was found to agree quite closely with what might be expected from the concentration of normal milk. The fluidity of the sample in the case of evaporated cream was no doubt the chief cause why the tin should be dissolved therein, rather than in the semi-solid condensed milk.

Method of Treatment of Condensed Milk for Examination for Metallic Impurities. — The reduction of a large quantity of such viscous material as condensed milk, molasses, syrups and the like to an ash is a somewhat difficult task. For the purposes of ashing such substances as these, a modification of the method of Budde and Schou* for determining nitrogen was employed, with very satisfactory results. The sample is mixed with about 33 per cent. of concentrated sulphuric acid in a porcelain dish, and an electric current of from 1 to 4 amperes is passed through it. In about fifteen minutes a good black char is produced, and the sample may then be incinerated at once over a free flame without the troublesome frothing and swelling up that results in the direct burning of all syrupy substances. After reduction to an ash, the electrolytic method was employed for the determination of tin in canned goods, as described in the previous report.†

Foods exclusive of Milk.

Evasions of the Compound Law. — Articles of food are still found in the market marked with the simple label of "compound," with

* Zeit. Anal. Chem., 1899, pages 38, 344–348.

† Thirty-first annual report of the State Board of Health, page 625.

an apparent attempt to conform to the old law, long since repealed. The law now in force, requiring such articles of food to be plainly marked with the name and percentage of ingredients, has been on the statute book for four years. One sample of "compound" coffee examined during the year was found to consist entirely of peas, wheat and pea hulls, no coffee whatever being found in it. This package was simply marked "compound," nothing being said about the names or percentage of the ingredients.

That part of the statute which provides that the nature of the adulterant be *plainly* marked is quite frequently evaded. The following label is an example of this: —

These goods are of the same high quality heretofore
furnished by us, and are prepared from fresh fruit and refined sugar with
the addition of sufficient corn syrup to prevent
crystallization and a small amount of preservative to prevent fermentation.

FRESH FRUIT

STRAWBERRY JAM

CURTIS BROTHERS CO.,

ROCHESTER, N. Y., U. S. A.

The portion of this label which actually tells of the presence of the two chief adulterants is so placed on the label as to be rarely if ever seen by the purchaser, besides being in such indistinct type. The words "with the addition of sufficient corn syrup to prevent crystallization, and a small amount of preservative to prevent fermentation," are printed down the side and backwards across the bottom, so that the package has to be turned in all directions in order to be read. In this, as in other cheap preparations of this class, the "corn syrup" was largely in excess of the "refined sugar." The preservative present was sulphurous acid.

Another common method of evading the compound law is to print a wholly deceptive label, containing proportions of ingredients entirely different from what actually appear on analysis. For in-

stance, a sample labelled "California honey, composed of 70 per cent. honey and 30 per cent. corn syrup," proved on analysis to contain 70 per cent. of the corn syrup. Another sample of compound honey, the label of which read "Compound of 50 per cent. honey and 50 per cent. corn syrup," was found to contain 84 per cent. of the glucose, or corn syrup.

There are, however, occasional instances of attempts on the part of the manufacturers to comply with the law. The following labels are examples, the percentage of ingredients in these cases being substantially correct: —

HONEY DRIPS.

Compound of { 90 per cent. pure corn syrup.
10 per cent. pure cane syrup.

It should be said, however, that this article, wherever possible, is undoubtedly sold for pure honey.

"KAIROMEL BRAND" CORN SYRUP.

90 per cent. pure corn syrup.
10 per cent. pure cane syrup.

BOSTONIAN FRUIT JELLY. — STRAWBERRY FLAVOR.

Mixture —	Sugar,	.30
	Glucose,	.30
	Apple juice,	.39
	Citric acid,	$\frac{1}{2}$ of .01
	Fuchsine,	$\frac{1}{32}$ of .01
	Concentrated fruit juice named on label,	$\frac{1}{3}$ of .01

Butter.

One hundred and eighty-eight samples were collected and examined during the year, of which 11 were found to consist of oleomargarine. There is no doubt that oleomargarine is illegally sold for butter in many instances throughout the State, frequently by small pedlers, whom it is exceedingly difficult in most cases to apprehend. Several samples of renovated butter, marked in accordance with the law, were collected.

Canned Goods.

The crusade begun last year against "soaked goods" was continued the present year. Twenty samples of suspected canned peas were examined, 18 of which were found to be of the "soaked" variety. The following brands were found to be of this character: —

Brand.	Manufacturer.
Rosebud Early June Peas,	Charles G. Summers & Co., Baltimore.
Rosemary Early June Peas,	Fulton Packing Company, Boston.
Ruby Early June Peas,	H. D. Valdrews Company, Boothwyn, Del.
Early June Peas,	F. J. Ruth & Co., Baltimore.
Marrowfat Peas,	H. O. Jones & Co., Chelsea, Del.

Other canned goods examined were condensed soup, baked beans, canned blueberries, and canned pumpkin, all of good quality.

Cheese.

Twenty-seven samples of cheese were examined, none of which could be considered adulterated, in the absence of a law fixing the standard for fat, although several were of the skimmed-milk variety.

Cocoa and Chocolate.

Thirty-three samples of these preparations were analyzed, 12 of which were adulterated. The adulterants found in the cocoas were sugar, wheat, corn and arrowroot. The worst sample contained 25 per cent. of corn. Iron oxide was found in a number of samples of chocolate.

Coffee.

Only 6 samples out of 130 examined were found to be actually adulterated. The worst sample contained fully 90 per cent. of pea hulls, peas and chicory. A sample manufactured by the Potter-Parlin Company, labelled "strictly pure," consisted largely of wheat, peas, charcoal and dirt. The ratio of adulteration of coffee has been gradually decreasing during the last few years, owing largely to the fact that there are so many low-grade coffees in the market, sold at a low price, that it is no doubt considered much safer to substitute these low-grade goods for pure "Mocha and Java," rather than to take the risk of adding foreign substances to a higher-grade coffee. It is impossible, by means of a chemical analysis, to discriminate between a high and low grade coffee.

Confectionery.

Thirty-one samples out of the 78 examined were adulterated. The high rate of adulteration this year is due to the collection and examination of so-called "brandy-drops," under the law making it

illegal for dealers to sell to a child under sixteen years of age any candy or other article enclosing liquid or syrup containing more than 1 per cent. of alcohol. Thirty-nine samples of chocolate brandy drops, which had been sold to a boy under 16, were analyzed, and 30 were found with syrup containing more than 1 per cent. of alcohol. Several samples were found containing more than 4 per cent. by weight of alcohol. This class of confectionery was examined as a result of a case of intoxication of a young school girl, caused by eating these drops.

Method. — The syrup was collected from a number of the brandy drops by carefully cutting off one end with a knife and pouring the contents into a beaker. As a rule, 18 of the drops were found to yield 30 to 40 grammes of the syrup. A weighed amount of the syrup after diluting with one-half its volume of water was distilled in the usual apparatus for determining alcohol. The specific gravity of the weighed distillate was determined. The percentage of alcohol, equivalent to the specific gravity, was ascertained from the alcohol table. This was multiplied by the weight of the distillate, and the result, divided by the original weight of the syrup, gave the percentage of alcohol in the syrup.

Cream of Tartar.

Three hundred and eighty-six samples of cream of tartar were analyzed. Eleven were found to contain the usual adulterants, being in most cases mixtures of calcium sulphate, acid phosphate of lime and corn starch. The worst adulterated sample contained only 20 per cent. of pure bitartrate of potash. Several samples contained alum.

Honey.

Eighty-eight samples were analyzed, 39 of which were adulterated, for the most part with the usual glucose or with cane sugar. In some instances both of these adulterants were found present. The worst specimen contained 90 per cent. glucose. Compound honey, evasively marked, is discussed elsewhere under "Evasions of the Compound Law."

Maple Sugar and Maple Syrup.

Eighty-two samples of these products were collected and examined, 8 of which were adulterated by the admixture of commercial glucose. One sample of maple syrup contained 76 per cent. glucose.

Molasses.

Twelve samples were found to be reinforced with glucose, out of the 86 examined. Ninety per cent. of one sample was found to be glucose.

The Determination of Glucose in Molasses, Maple Syrup, etc. — While it is true that it is not necessary, in enforcing the food and drug act, to determine the exact amount of adulterant, it is often convenient to be able to testify approximately as to the amount present. It is impossible to determine exactly how much glucose is present, by reason of the fact that commercial glucose varies widely in its composition as to the percentage of the three optically rotative sugars, — dextrine, dextrose and maltose; it is, however, a simple matter to arrive at a very close approximation of the amount of added commercial glucose by the following method: —

A normal weight of the sample to be examined, namely, 26.048 grammes, is dissolved in 50 to 75 cubic centimeters of water in a graduated 100 cubic centimeter flask, clarified in the case of molasses by the addition of sub-acetate of lead, and in the case of syrup by alumina cream, and finally made up to the mark and filtered. The 100 millimeter tube of the polariscope is filled with the clear filtrate, and the reading multiplied by 2 gives the direct polarization. Fifty cubic centimeters of the filtrate are treated with 5 cubic centimeters of concentrated hydrochloric acid. The solution is made up to 100 cubic centimeters, and inverted after the usual manner at a temperature not exceeding 68° C., after which it is cooled and filtered. The filtrate is then polarized in a tube of the same length and at the same temperature as before, and this reading multiplied by 4 gives the true invert reading. The sucrose is found by Clerget's formula,

$$R = \frac{100\ S.}{144 - \frac{1}{2}\ T.}$$

wherein —

R = sucrose.
S = difference of the two polarizations before and after inversion.
T = temperature at which the reading is taken.

The percentage of sucrose, deducted from the first direct reading gives the reading due to the commercial glucose; this result, di-

vided by 175,* gives approximately the percentage of commercial glucose present in the sample. One hundred and seventy-five has been found to be the polarizing figure of the average commercial glucose of the grade used by manufacturers of cheap molasses, maple syrup and the like. For this purpose a number of samples of glucose syrup have been obtained by the Board directly from various dealers in these products, and they were all found to polarize within a few degrees of 175.

For example, suppose a sample of molasses is found to polarize directly at 108.3° to the right on the cane sugar scale and after inversion at 53.9° to the right, the temperature being 22° C. Using the Clerget formula, the amount of sucrose present will be found to be —

$$\frac{108.3 - 53.9}{133} = 40.9 \text{ per cent.}$$

$$108.3 - 40.9 = 67.4, \text{ the reading due to glucose.}$$

$$\frac{67.4}{175} = 38.5, \text{ the approximate percentage of commercial glucose in the sample.}$$

That this method gives a very close approximation to the amount of glucose present has been shown by repeated experiments in the laboratory, using mixtures containing various known proportions of molasses and commercial glucose.

Lard.

Out of 30 samples examined, 4 were found to be adulterated by admixture with cotton-seed oil.

Syrup.

Five out of the 8 samples examined were found adulterated. One sample of golden syrup contained 80 per cent. of glucose. Several of the so-called fruit syrups were found to be preserved with salicylic acid.

Tea.

Forty-one samples of tea were examined, 3 of which were classed as adulterated by reason of excess of tea stems. In the case of tea,

* In the 31st annual report of the State Board of Health for 1899, page 627, 150 is given as the polarizing figure for commercial glucose. It has since been found by a more thorough investigation that the grade of commercial glucose polarizing at 150 is the one commonly employed as an adulterant of jellies and jams, while the grade best adapted by its consistency for admixture with honey and molasses, polarizes at or about 175° on the cane sugar scale, and has a density of 42° Beaumé.

as in coffee, the most common fraud seems to be the substitution of inferior brands, which is not, strictly speaking, a form of adulteration, and comes within the province of the expert tea taster rather than that of the analyst.

Vinegar.

The ratio of adulteration of vinegar is higher than ever before, by reason of the fact that considerable attention has of late been paid to the large class of vinegars which, while in many cases conforming to the legal standard of total solids and acidity, are not pure cider vinegar. If only those samples below the standard of acidity and solids were reckoned as adulterated, the ratio of adulteration would have been 42.2 per cent., instead of 55.4, the true figure for the year. In addition to the regular table, which has been from year to year introduced in past reports, showing the percentage of acetic acid and solids in the samples of vinegar analyzed, additional tables are given this year, which summarize the results of analyses of a large number of pure and adulterated vinegars. The following is the usual table of vinegars examined during the year, showing the acidity and total solids, the full-faced type indicating the samples that are below the standard: —

Vinegar.

Per Cent. Acetic Acid.	Per Cent. Solids.	Per Cent. Acetic Acid.	Per Cent. Solids.	Per Cent. Acetic Acid.	Per Cent. Solids.	Per Cent. Acetic Acid.	Per Cent. Solids.
7.00	3.33	4.86	2.30	4.62	3.78	**4.44**	**1.60**
5.90	**.40**	**4.80**	**1.97**	4.60	2.57	**4.44**	**–***
5.44	**1.80**	**4.80**	**1.03**	4.56	2.60	4.66	2.92
5.36	3.40	4.83	2.71	4.54	3.97	**4.44**	**–***
5.28	2.15	4.79	2.63	4.54	3.90	**4.42**	**2.55**
5.28	**1.53**	**4.76**	**1.89**	4.54	2.94	**4.42**	**2.75**
5.14	**.36**	4.76	3.70	4.54	2.70	**4.40**	**2.51**
5.20	3.35	4.76	2.05	4.51	3.80	**4.40**	**1.50**
5.20	2.50	4.92	2.90	4.51	2.30	**4.40**	**2.20**
5.30	2.29	4.72	2.00	4.50	3.73	**4.40**	**1.80**
5.30	2.10	4.71	2.14	4.50	2.18	**4.40**	**1.80**
5.12	**.53**	**4.70**	**1.90**	4.50	3.05	**4.38**	**.29**
5.08	3.00	4.70	2.00	4.50	2.69	**4.38**	**.97**
5.00	2.40	4.70	2.69	4.50	2.70	**4.36**	**.68**
5.00	**1.75**	4.70	2.09	4.50	2.90	**4.34**	**.62**
4.94	2.48	4.62	2.50	**4.46**	**–***	**4.30**	**1.93**
4.90	2.57	**4.62**	**1.33**	**4.46**	**2.80**	**4.32**	**.70**
4.82	2.71	4.62	2.58	**4.44**	**2.10**	**4.30**	**1.40**
4.80	2.11	4.62	2.48	**4.44**	**1.70**	**4.08**	**3.35**
4.86	3.65	4.62	2.49	**4.44**	**1.92**	**3.98**	**.55**

* White wine vinegar.

A large amount of vinegar sold as cider vinegar is made by the so-called quick process, in many cases not from cider at all; and the solids are made up wholly or partly by apple pomace, which in many instances has been completely exhausted of malic acid. Sometimes apple or cider jelly is added to increase the solids, and the apple jelly in many cases contains commercial glucose. Much information may be gained from the ratio of the ash to the total solids, which ratio, if abnormally low, is good evidence that the sample is not a genuine cider vinegar. From the inversion of the sugar during the process of acetic fermentation, a genuine cider vinegar should always polarize to the left of the zero point, and therefore a right-handed polarization is absolute evidence of adulteration. While it is true that a precipitate with lead acetate does not necessarily show the presence of malates in the vinegar, in view of the fact that other substances than malic acid, such, for instance, as molasses, will cause a precipitate, it is absolutely sure, on the other hand, that the absence of a precipitate shows adulteration.

In the table which follows are given data of the analyses of 7 samples of cider vinegar of known purity: —

Cider Vinegar of Known Purity.

Per Cent. Acetic Acid.	Per Cent. Total Solids.	Per Cent. Ash.	Per Cent. Ash in Total Solids.	Polarization in 200 Millimeter Tube.	Lead Acetate.
5.42	2.47	.21	8.50	— 2.6	Precipitate.
5.20	2.21	.22	9.95	— 2.0	Precipitate.
4.74	2.35	.19	8.09	— 2.6	Precipitate.
4.64	2.59	.29	11.23	— 2.4	Precipitate.
4.62	2.58	.24	9.30	— 3.1	Precipitate.
4.55	2.59	.28	10.87	— 2.0	Precipitate.
4.54	2.59	.37	14.32	— 1.0	Precipitate.

In the following table are included samples of vinegar brought in for examination, all of which are probably pure cider vinegar, but some of which, as indicated by the full-face type, are below the legal standard in acidity or total solids, or both: —

Cider Vinegar.

Per Cent. Acetic Acid.	Per Cent. Total Solids.	Per Cent. Ash.	Per Cent. Ash in Total Solids.	Polarization in 200 Milli-meter Tube.	Lead Acetate.
5.30	2.10	–	–	—2.4	Precipitate.
5.30	2.29	–	–	—3.0	"
5.00	1.75	–	–	—1.8	"
5.00	2.40	–	–	—3.0	"
4.90	2.57	–	–	—2.0	"
4.86	3.65	.35	9.04	—5.8	"
4.76	1.89	–	–	—2.2	"
4.71	2.14	–	–	—1.2	"
4.70	2.69	–	–	—3.2	"
4.70	2.00	–	–	—2.4	"
4.70	1.90	–	–	—3.0	"
4.62	3.78	–	–	— .6	"
4.62	2.58	.24	9.30	—3.1	"
4.62	2.49	–	–	—2.0	"
4.61	2.50	–	–	—4.2	"
4.51	3.80	–	–	—3.1	"
4.51	2.70	–	–	—4.4	"
4.50	2.18	–	–	—2.2	"
4.44	1.74	–	–	—2.4	"
4.42	2.55	–	–	—3.0	"
4.40	1.80	–	–	—2.2	"
4.40	1.80	–	–	—1.8	"
4.34	.62	–	–	— .8	"
4.36	.68	–	–	— .2	"
4.30	1.40		–	—1.4	"
4.20	.67	–	–	— .2	"

Forty-six samples of vinegar out of the 83 examined were adulterated, or below the standard.

The following table includes samples of adulterated vinegar, none of which were probably made from cider. It will be noticed that in several of the samples the amount of glucose must have been abnormally large, on account of the very high right-handed polarization, in one case amounting to nearly 10 degrees. A large amount of phos-

phate was found in one sample. The data given under the head of "polarization" are the readings obtained from the undiluted vinegar, which in most cases could be readily clarified by simply filtering twice through the same filter. Occasionally, however, a sample has to be clarified by the addition of 10 per cent. of alumina cream.

Adulterated Vinegar.

Per Cent. Acetic Acid.	Per Cent. Total Solids.	Per Cent. Ash.	Per Cent. Ash in Total Solids.	Polarization in 200 Millimeter Tube.	Lead Acetate.
5.90	.40	–	–	+1.4	No precipitate.
5.14	.36	–	–	.0	No precipitate.
5.12	.53	–	–	+ .6	No precipitate.
4.83	3.70	.32	8.65	+8.0	No precipitate.
4.82	2.71	.13	4.80	+9.6	Heavy precipitate.*
4.80	1.97	.20	10.15	+ .9	Precipitate.
4.80	1.03	.27	14.75	+1.1	Precipitate.
4.66	2.92	.20	6.49	+2.2	No precipitate.
4.60	2.57	–	–	+2.6	No precipitate.
4.56	2.60	–	–	+7.0	–†
4.54	3.97	.19	4.78	+5.6	No precipitate.
4.54	3.90	.32	9.72	+5.0	No precipitate.
4.54	2.94	.23	7.82	+5.0	No precipitate.
4.54	2.70	.23	8.52	+ .4	Precipitate.
4.50	3.05	–	–	+2.2	No precipitate.
4.50	2.92	.22	7.52	+ .9	No precipitate.
4.50	2.69	–	–	+2.8	No precipitate.
4.46	2.80	–	–	+2.6	No precipitate.
4.42	2.75	–	–	+3.2	Slight precipitate.
4.42	2.10	–	–	+9.2	Precipitate.
4.40	2.51	.20	11.15	+1.1	Precipitate.
4.40	.97	–	–	+ .4	No precipitate.
4.38	.29	–	–	+1.6	No precipitate.
4.32	.70	.09	12.86	–	No precipitate.
4.08	3.35	–	–	+1.2	Precipitate.
3.98	.55	–	–	+1.8	Slight precipitate.

* Cider vinegar to which apple jelly containing glucose had been added for the purpose of increasing the solids after watering.

† This sample contained a large amount of phosphate, and consequently the test for malates is obscured.

Olive Oil.

Hitherto the olive oil samples collected have been included among the drugs, but it has been thought best to discriminate between the samples collected in drug stores and those purchased of grocers. Fourteen of the latter variety were collected, 9 of which were adulterated. Five of the 9 samples consisted wholly or in part of the usual substitute, cotton-seed oil, but 4 samples, all of one brand, contained a very large admixture of corn oil.

This brand was the product of the Dove Pure Oil Company, and was very attractively put up in neat bottles, bearing the ingenious label: —

Superior in
Quality, Purity and Flavor
to any
Olive Oil
in the market.

Below this was represented the trade-mark, which consisted of a dove bearing an olive branch.

Several samples of spurious olive oil were examined, having labels intended to convey the impression that the oil was put up abroad; but the French labels were apparently prepared by Yankees, who were not over familiar with the language. Three samples of these French (?) labels are the following: —

Huile D'Salade.

C. L. H. Cartoux,
Nice.

Huile H'Olive-Vierge.

G. Cartoux,
Nice.

Huile D'Olive Vierce
D'Aix.
C. P. Deydier,
De Puechme Jean.

Still another native cotton-seed oil is sold in bottles, the label of which, besides bearing a picture of a branch containing olive fruit, has the following: —

Olio D'Oliva Toscano
Lucca.
Sublime.

Vanilla Extracts.

Five samples only were examined, 3 of which contained coumarin. One of these was put up by James H. Dalton Company, Boston, another by the Nickel Extract Company of Philadelphia, and the

third had no address. One brand manufactured by the Winthrop Extract Company of Winthrop, Mass., contained .3 per cent. of vanillin, but was entirely artificial, containing no part of the vanilla bean.

Spices.

Under a separate heading are shown and described some of the distinctive characteristics of the structure of various ground spices under the microscope.

In many respects the character of spice adulteration has been changing of late. As a matter of fact, fewer samples are found adulterated with the inert materials so often found in past years, the tendency being to use cheaper grades and in many cases damaged or inferior products. Clove stems, pepper shells and mustard hulls are more often found in large quantity than formerly, so that it is incumbent on the analyst to discriminate carefully between the amount of such substances allowable as accidental and the amount purposely added to adulterate.

Allspice. — Three samples of allspice out of 154 examined were adulterated. One of them was found to contain 85 per cent. of wheat and nut shells.

Cassia. — One hundred and ninety-three samples were examined, 3 of which were adulterated, the worst sample containing 25 per cent. of ground foreign bark.

Cayenne. — Twenty-eight samples were examined and 4 were found to be adulterated, the adulterants being corn, wheat, turmeric, ginger and an aniline dyestuff.

Cloves. — Two hundred and three samples were analyzed and 18 were found to be adulterated. Clove stems, nut shells, starch and fruit stones were found in different cases as adulterants. One sample contained 90 per cent. of wheat, turmeric, charcoal and "sweepings."

Ginger. — Two hundred and thirty-four samples were examined, 11 of which were adulterated, the adulterants being wheat, turmeric, rice and pepper. One sample contained 35 per cent. of rice starch.

Mace. — Six adulterated samples were found, out of 30 examined. Wild mace, corn and roasted wheat were the adulterants found. The worst sample contained 75 per cent. of corn; another was found with 30 per cent. of wild mace.

Mustard. — Three hundred and twenty-six samples were examined, 76 of which were impure, mustard hulls, corn, wheat, turmeric and rice constituting the chief adulterants found. One sample contained 90 per cent. of wheat and turmeric, another 25 per cent. of rice, a third 30 per cent. of wheat and buckwheat. That mustard hulls are used as an adulterant of ground mustard flour there can be no doubt. In the ordinary grinding of mustard, especially of the better grade, a part of the oil is ordinarily removed and a considerable portion of the hulls is sifted out. It is claimed by some manufacturers that the hulls thus removed are not used as an adulterant of cheaper mustard flours, in view of the fact that it is difficult or impossible to grind them finely enough, but that they are used up in the manufacture of compound mustard pastes. A sample of ground mustard was recently found in which it was noticed that a large number of yellow lumps were distributed through it. These lumps were picked out, transferred to the microscope slide and crushed and rubbed out under the cover glass. Examined under the microscope, they were found to consist entirely of a mixture of mustard hulls and turmeric, which would seem to show that hulls were present in this case as an adulterant.

Nutmeg. — Fifteen samples were examined, only 1 of which was adulterated, containing 15 per cent. of wheat.

Pepper. — Four hundred and fifteen samples of pepper were analyzed; 23 were found adulterated. In these were found wheat, ginger, pepper shells, olive stones and buckwheat. One sample contained 75 per cent. of wheat bran, another 35 per cent. of olive stones. A sample of so-called sweet pepper was found to consist of the pungent red seaweed known as dulse or pepper-dulse.

Paprika. — This spice, which is a species of capsicum, otherwise known as Hungarian red pepper, is a favorite on account of its very brilliant natural red color. Three samples were examined, 1 of which was found to contain an admixture of a small starch, presumably millet. None were found to be artificially colored.

Miscellaneous Foods.

Samples of the following articles were examined during the year and found to be of good standard quality, or to contain nothing that could be considered as adulterants:

Apple butter, arrowroot, beer, bread, cereal milk (consisting of dried pulverized milk solids, added milk sugar, wheat and barley), "Chicken Tamale," chocolate pudding, cider, coffee extract, food colors, gelatine and gelatine preparations, "Honey Scotch" (a mixture of glucose and honey), horse-radish, "Ko-nut" (cocoanut oil), "lemon sour" (a carbonated sugar solution flavored with lemon), macaroni, mince meat, peanut butter, "Rillets" (a preparation of goose fat, ham and chicken, with truffles and spices), sage, salad oil, saleratus, "Tartarine" (a mixture of calcium sulphate, calcium acid phosphate, bicarbonate of soda and corn starch), "Teaette" and thyme.

Samples of miscellaneous foods found adulterated, or worthy of comment for any reason, are the following: —

Baking Powder. — Between 200 and 300 samples of baking powder have been examined by the Board during the past fifteen years. There is no standard of purity of these preparations in Massachusetts. It is to be regretted that no law exists compelling baking powders of all classes to be marked with the name and percentage of their ingredients, especially as baking powder is not strictly a food, but, as it were, an instrument or tool to bring about the leavening of the bread. It would seem as if the public should be allowed to select in all cases the combination of ingredients most desired.

Cake Icing (vanilla). — This was a gelatine solution containing no vanillin, being flavored with coumarin.

Jams and Jellies. — Thirty-nine samples of these preparations were examined, 33 of which were classed as adulterated, being cheap substitutes of the various purported fruits, consisting largely of the usual mixture of apple pulp and glucose, described in past reports. Some of these had labels containing a list of ingredients, with the percentage present, but in most instances these labels were misleading and deceptive. In nearly all cases artificial coloring matter was employed to conceal the inferior condition of the goods. The color-

ing matter in a large number of samples of these goods was examined by dyeing worsted in the boiling diluted sample. The colors used in a set of these jams, the product of a single manufacturer, were identified by boiling pieces of white worsted in solutions of the jams, and examining the dyed fibre with various reagents. The quince jam was found to be colored with primulin orange; the raspberry, strawberry and damson with azoe-osin; and the apricot and pineapple with Bismarck brown.

Ketchups. — Samples of ketchup, table sauces, etc., were examined for preservative, and the following brands were found to contain benzoic or salicylic acid: —

Brand.	Preservative Found.	Manufacturer.
Walker's,	Benzoic acid,	Walker Chemical and Extract Company, Chelsea, Mass.
Home Made,	Benzoic acid,	No address.
Standard,	Benzoic acid,	Standard Manufacturing Company, Wheeling, W. Va.
Sunnyside,	Benzoic acid,	Tiptop Ketchup Company, Cincinnati, O.
Snider's Home Made,	Benzoic acid,	T. A. Snider Preserving Company, Cincinnati, O.
Heinz,	Benzoic acid,	H. J. Heinz Company, Pittsburg, Pa.
Heinz Keystone,	Salicylic acid,	H. J. Heinz Company, Pittsburg, Pa.
Hero,	Salicylic acid,	American Relish Company, Indianapolis, Ind.

One is not always sure of finding the same kind of preservatives in preparations of the same name or brand. For instance, samples of Snider's ketchup have been found preserved with benzoic acid, and some were found free from preservative. Three varieties of Heinz' ketchup, put up in octagon-shaped bottles and bearing similar labels, were found, one containing benzoic acid, one with salicylic acid and the third with no preservative whatever.

Lemonade Mixture. — Several samples of so-called Eiffel Tower Lemonade, purporting to be made from nothing but Messina lemons, were examined, and found to be approximately of the following composition: —

	Per Cent.
Tartaric acid,	32.0
Citric acid,	15.6
Cane sugar,	42.0
Moisture, lemon oil, aniline color, etc.,	10.4
	100.0

The contents of a ten-cent package of this mixture were to be used in making ten pints of the alleged lemonade.

Orange Marmalade (Fort Henry Brand). — This preparation, manufactured by the West Virginia Preserving Company of Wheeling, has the following formula on the bottle : —

	Per Cent.
Fresh fruit,	20
Apple juice,	30
Sugar,	15
Corn syrup,	35

This was found on analysis to contain 62 per cent. of corn syrup or glucose.

Pickles. — Ten samples of pickles were analyzed, all of which were found to contain sulphuric acid.

Summary of Statistics of Food, Exclusive of Milk.

	Genuine.	Adulterated.	Total.	Per Cent. of Adulteration.
Allspice,	151	3	154	1.9
Butter,	177	11	188	5.8
Canned goods,	6	16	22	72.7
Cassia,	190	3	193	1.5
Cayenne,	24	4	28	14.3
Cheese,	27	–	27	0.0
Chocolate,	21	12	33	36.3
Cloves,	184	18	202	8.9
Coffee,	124	6	130	4.6
Condensed milk,	46	2	48	4.2
Confectionery,	47	31	78	39.7
Cream of tartar,	375	11	386	2.8
Ginger,	223	11	234	4.7
Honey,	49	39	88	44.3
Lard,	26	4	30	13.3
Mace,	24	6	30	20.0
Maple sugar,	27	–	27	0.0
Maple syrup,	47	8	55	14.5
Miscellaneous,	87	101	188	53.7
Molasses,	74	12	86	13.9
Mustard,	250	76	326	23.3
Nutmeg,	14	1	15	6 6
Olive oil,	5	9	14	64.3
Paprika,	2	1	3	33.3
Pepper,	392	23	415	5.5
Syrup,	3	5	8	62.5
Tea,	38	3	41	7.3
Vinegar,	37	46	83	55.4
Totals,	2,670	462	3,132	14.2

Drugs.

The drugs examined have been for the most part, as in past years, chiefly those pharmacopœial preparations which experience has proved to be most liable to adulteration.

A number of samples of powdered spices have been collected from drug stores, and it is a significant fact that as a rule the ratio of adulteration is considerably higher in the case of spices purchased from drug stores than of spices bought of grocers. This is contrary to what one would naturally expect, in view of the fact that not only is a higher price paid for the drug store sample, but in many cases where a person wants an unusually pure article for medicinal purposes, as in the case of capsicum or mustard, for example, he instinctively turns to the drug store as being the appropriate place to get without question the pure article. Statistics would seem to show, however, that he had better run his chances with the corner grocery. The same is true also with regard to the liquors of the pharmacopœia, such as brandy, whiskey, white and red wine, etc. In spite of the higher price paid in the drug stores for these articles, statistics in the Board's reports do not show any improvement in quality over the liquors usually dispensed in the saloons throughout the State. A large number of the latter class have in past years been analyzed in this department.

Except in the case of the following articles, which call for special comment of some sort, a statement of the various drugs examined and the results of such examination will be found only in the summary of drug statistics on page 674 : —

Aqua Destillata. — It is difficult to see why samples of pure distilled water are so rarely dispensed from the average drug store. It would seem as if nothing could be more readily prepared by every druggist than this. As a matter of fact, however, the average sample of distilled water collected throughout the State, more often than not contains a high residue, giving one the impression that in most cases the ordinary tap water is the article dispensed. The residues of the samples collected and examined during the year are as follows : —

Aqua Destillata.

[Solids. Parts per 100,000.]

.0	.7	1.7	3.1	5.6	17.3
.0	1.3	2.0	4.0	9.8	17.5
.3	1.3	2.4	4.6	12.8	

Calx Chlorata. — This common disinfectant as ordinarily purchased seldom contains more than a small percentage of the available chlorine which the pharmacopœia calls for, namely, 35 per cent. Only one brand of those examined during the year even approximated this figure. The brands examined, with the amount of available chlorine present, are given in the following table: —

Calx Chlorata.

Brand.	Per Cent. of Available Chlorine.	Brand.	Per Cent. of Available Chlorine.
Acme, ...	0.43	Acme, ...	12.91
Brookman's, . . .	2.50	Brookman's, . . .	17.20
Acme, ...	9.72	Quaker, ...	32.00

Capsicum. — Nearly one-third of the samples of this drug examined were found to be adulterated, the adulterants being corn, wheat and turmeric. One sample contained 75 per cent. of these ingredients.

Caryophyllus. — One-third of the samples of powdered cloves purchased in drug stores were found to be adulterated with such articles as corn starch, roasted wheat, peas and charcoal. One sample contained 40 per cent. of corn starch.

Cera Alba. — Three samples of the 12 examined were found adulterated with paraffine. This form of sophistication is rendered apparent from the specific gravity of the product. One sample contained 15 per cent. of paraffine.

*Method of Determining Specific Gravity of Beeswax.** — Place a weighed rod of the wax, about 1 to 1.5 cm. long by .5 cm. diameter, in an accurately marked 50 cc. flask, and run in water from a burette till the water level reaches the mark. Fifty cc. minus the burette reading represent the volume occupied by the wax. The rod should be made to lie flat on the bottom of the flask, so that the incoming water will force its ends against the sides and prevent the end from rising above the mark. The volume of the rod, divided by its weight, gives its specific gravity. The specific gravity of various

* Bulletin 13, U. S. Department of Agriculture, Division of Chemistry, page 842.

mixtures of wax of .969 specific gravity and paraffine of .871 are given in the following table, prepared by Wagner, so that from the specific gravity of the mixture the percentage of paraffine can be calculated: —

Wax (Percentage).	Paraffine (Percentage).	Specific Gravity.	Wax (Percentage).	Paraffine (Percentage).	Specific Gravity.
–	100	.871	75	25	.942
25	75	.893	80	20	.948
50	50	.920	100	–	.969

Extractum Glycyrrhizæ. — Fifteen samples were found to be adulterated, out of 21 examined, by the addition of corn or wheat, or both.

Extractum Zingiber Fluidum. — Two samples were examined, 1 of which contained no oil of ginger, being made from exhausted powder.

Glycerinum. — One hundred and eleven samples were examined, 76 of which were found to be arsenical. Considerable improvement is found in the state of the market as regards the presence and amount of arsenic in glycerine. When the drug was first examined for arsenic by the Board, an absolutely non-arsenical sample was hard to find. The manufacture of an arsenic-free product has apparently been the subject of considerable experiment, and beneficial results are beginning to be apparent. One sample was found to contain 8 parts of arsenic in 100,000.

Limonis Succus. — All 6 of the brands examined were found to contain an added preservative, as follows: —

Lime Juice.

Brand.	Preservative.	Citric Acid (Per Cent.).
Ashmont W. I., ...	Salicylic acid, ...	2.98
Blue Hill, ...	Salicylic acid, ...	3.15
Eclipse, ...	Salicylic acid, ...	3.50
Metropolitan, ...	Sulphurous acid, ...	3.00
Montego, ...	Sulphurous acid and salicylic acid,	2.80
Montego, ...	Sulphurous acid and salicylic acid,	2.28

Opii Pulvis and *Tinctura Opii.* — Five samples of the former and 20 of the latter were analyzed, with the following results: —

Opii Pulvis.

[Percentage of morphine.]

15.3	13.5	12.6	13.0	11.6

Tinctura Opii.

[Grammes of morphine per 100 cubic centimeters.]

1.30	1.28	1.13	1.00	.80	.37	.30
1.30	1.28	1.10	.91	.45	.32	.30
1.30	1.17	1.07	.81	.45	.30	

The standard of the pharmacopœia is from 13 to 15 per cent. of morphine in the powder, and from 1.3 to 1.5 per cent. in the tincture.

Pimenta. — The 1 sample of this powdered drug found adulterated contained a considerable admixture of roasted wheat.

Pepper. — Two samples of black pepper purchased in drug stores were found to be adulterated, 1 containing 60 per cent. of ground olive stones; another contained an admixture of millet.

Sulphur Lotum. — Nine samples out of the 11 examined were found to contain free sulphuric or sulphurous acid, not having been properly washed.

Sulphur Præcipitatum. — Forty-seven samples were examined, of which 34 were highly adulterated with calcium sulphate.

Tinctura Iodi. — Nearly all of the samples of this drug were found to contain an insufficient amount of iodine, as shown by the following figures: —

Tinctura Iodi.

[Percentage of U. S. pharmacopœiai strength.]

216	100	90	85	82	80	78	76	74	70	62	54
150	100	90	85	82	80	78	75	73	69	62	54
148	100	89	85	82	79	77	75	73	68	62	50
148	100	88	84	81	79	77	75	72	67	60	46
111	100	87	84	81	79	77	75	72	67	58	44
100	100	87	84	80	79	77	74	72	67	57	35
100	92	87	83	80	78	77	74	72	65	57	33
100	92	87	83	80	78	77	74	71	64	55	33
100	91	86	83	80	78	77	74	71	63	54	

Five samples were found with more than the required strength of the pharmacopœia, which conclusively disproves the plea commonly advanced by manufacturers of the weak tinctures, that it is impossible to produce a tincture of iodine of the pharmacopœial strength.

Tinctura Nucis Vomicæ. — Two of the 7 samples examined fell below the required strength, the standard being .3 gramme of alkaloids in 100 cubic centimeters. The samples varied from .138 to .464 grammes of alkaloid per 100 cubic centimeters.

Pharmacopœial Liquors. — The following figures show the percentage of alcohol by weight and of solids in the samples of whiskey, brandy, red wine and white wine examined through the year: —

Spiritus Frumenti.		Spiritus Vini Gallici.		Vinum Album.		Vinum Rubrum.	
Per Cent. Alcohol.	Per Cent. Solids.	Per Cent. Alcohol.	Per Cent. Solids.	Per Cent. Alcohol.	Per Cent. Solids.	Per Cent. Alcohol.	Per Cent. Solids.
32.25	.09	43.33	2.70	16.67	4.50	14.45	11.62
34.10	.20	47.73	1.15			13.92	14.60
35.30	.80	46.09	1.29				
36.33	.69						
39.40	.60						
39.85	.80						
47.36	1.25						

Summary of Drug Statistics.

	Genuine.	Adulterated.	Total.	Per Cent. of Adulteration.
Acidum aceticum,	–	1	1	100.0
Acidum benzoicum,	1	–	1	.0
Acidum tannicum,	5	9	14	64.3
Æther,	4	5	9	44.4
Alcohol,	7	–	7	.0
Aqua ammoniæ,	6	4	10	40.0
Aqua destillata,	2	15	17	88.2
Argenti nitras,	2	–	2	.0
Bismuthi subcarbonas,	4	–	4	.0
Bismuthi subnitras,	4	–	4	.0
Calx chlorata,	1	5	6	83.3
Capsicum,	30	13	43	30.2
Caryophyllus,	6	3	9	33.3
Cera alba,	9	3	12	25.0
Cerii oxalas,	1	–	1	.0
Chloroformum,	1	3	4	75.0
Cinnamomum cassia	22	1	23	4.2
Extractum capsici fluidum,	1	-	1	.0
Extractum glycyrrhizæ,	6	15	21	71.4

Summary of Drug Statistics — Concluded.

	Genuine.	Adulterated.	Total.	Per Cent. of Adulteration.
Extractum zingiberis fluidum,	1	1	2	50.0
Ferri et quininæ citras,	3	3	6	50.0
Ferri et strychninæ citras,	5	1	6	16.6
Glycerinum,	35	76	111	68.5
Iodoformum,	2	–	2	.0
Limonis succus,	–	7	7	100.0
Lycopodium,	2	–	2	.0
Miscellaneous,	28	109	137	80.0
Oleum æthereum,	–	1	1	100.0
Oleum limonis,	3	3	6	50.0
Oleum olivæ,	21	8	29	27.6
Opii pulvis,	4	1	5	20.0
Pimenta,	2	1	3	33.3
Piper,	2	2	4	50.0
Potassii bitartras,	52	1	53	1.9
Pulvis glycyrrhizæ compositus,	9	–	9	.0
Sinapis alba,	2	1	3	33.3
Sodii boras,	1	–	1	.0
Sodii salicylas,	1	–	1	.0
Spiritus frumenti,	–	7	7	100.0
Spiritus juniperi,	1	–	1	.0
Spiritus vini gallici,	2	1	3	33.3
Spiritus ætheris nitrosi,	–	12	12	100.0
Sulphur lotum,	2	9	11	81.8
Sulphur præcipitatum,	13	34	47	72.3
Syrupus,	2	2	4	50.0
Tinctura digitalis,	5	4	9	44.4
Tinctura ferri chloridi,	–	1	1	100.0
Tinctura iodi,	10	98	108	90.7
Tinctura nucis vomicæ,	5	2	7	28.5
Tinctura opii,	6	15	21	71.4
Vinum album,	–	1	1	100.0
Vinum rubrum,	–	2	2	100.0
Zingiber,	46	1	47	2.1
Totals,	377	381	758	50.2

Miscellaneous Drugs.

Under this heading are included samples of the following, which were found to contain nothing injurious to health: —

Cough drops (containing menthol and honey), dyspepsia cure, Egyptian balm, face bleaches, headache cures (5 brands) and quinine pills.

Miscellaneous drugs found to be adulterated in some instances were the following: —

Grape Juice. — Eleven samples of unfermented grape juice were examined, 5 of which were found to contain either salicylic or boracic acid. The following brands were examined: —

Brand.	Preservative.	Manufacturers.
Alameda, . . .	Boracic acid, .	Alameda Company, Boston.
Los Angeles, . .	Boracic acid, .	Los Angeles Company, Boston.
Fenner's Chautauqua, .	Salicylic acid,	Chautauqua Fruit and Grape Juice Company, Westfield, N.Y.
Welch's, . . .	Salicylic acid,	Welch Grape Juice Company, Westfield, N. Y.
Welch's (Red Label), .	None, . .	Welch Grape Juice Company, Westfield, N. Y.
Otis Clapp & Sons, .	None, . .	Otis Clapp & Sons, Boston & Providence.
Vineland, . . .	None, . .	Vineland Grape Juice Company, Vineland, N. J.

Samples of grape juice examined by other analysts have been on record as containing formic aldehyde, but none of this preservative has been found in grape juice in this department. The general fuchsine test for aldehyde is inadequate for purposes of showing formaldehyde, in view of the fact that it would undoubtedly give a test with all samples of grape juice examined, since it has been found in this laboratory that an aldehyde is naturally present in grape juice.

Method of Detecting Formaldehyde in Grape Juice and Other Solutions. — Distill the suspected sample, mix the first portion of the distillate with pure milk, and test the mixture for formaldehyde with hydrochloric acid and ferric chloride.*

Or to the first portion of the distillate add a drop of a .5 per cent. solution of resorcin, and pour this upon concentrated sulphuric acid in a test tube. A rose-red zone at the junction of the two layers, with a white or pinkish coagulum above, indicates formaldehyde.†

General Summary.

	Genuine.	Adulterated.	Total.	Per Cent. of Adulteration.
Milk, ...	4,338	1,799	6,137	29.3
Foods not milk, ...	2,670	462	3,132	14.2
Drugs, ...	377	381	758	50.2
Totals, ...	7,385	2,642	10,027	26.3

* Thirty-first annual report State Board of Health, page 606.
† Mulliken and Scudder, Am. Chem. Jour. 21, pages 266-271.

Respectfully submitted,

ALBERT E. LEACH,
Analyst.

MICROSCOPICAL EXAMINATION

OF

FOODS FOR ADULTERATION.

By Albert E. Leach, *Analyst of the Board.*

MICROSCOPICAL EXAMINATION OF FOODS FOR ADULTERATION.

By Albert E. Leach, *Analyst of the Board.*

In many classes of food the microscope furnishes the analyst's chief reliance in the detection of adulterants, and often also in the determination of their approximate amount. This is especially true of such substances as the spices, coffee and cocoa. Indeed, the microscopic examination of such foods as these is oftentimes of far more importance in determining their purity than the chemical analysis. In other cases, as, for instance, in the examination of lard, processed butter, etc., the microscopical test is often useful mainly as confirmatory of the chemical analysis.

In the accompanying plates are illustrated the microscopical appearance of many of the typical adulterants of coffee, spices and other foods, as well as of actually adulterated samples of these foods, such as have been collected from time to time and examined in the regular course of the work of the department of food and drug inspection. A few of these photo-micrographs, taken by the late Dr. C. P. Worcester, have appeared in modified form in past reports of the State Board of Health, but have been here reproduced in order to make the set more complete, and for the reason also that the past reports containing them are now unavailable.

For the microscopical examination of powdered substances, such, for example, as spices, the sample should be ground fine enough to pass through a 60 to 80 mesh sieve. A small portion of the powder, placed on a microscope slide by means of a knife blade, is treated with a drop of distilled water from a medicine dropper, and rubbed out under the cover glass between the thumb and finger to the proper fineness. This quick and ready means of preparing a temporary slide is the one in common use in this laboratory for purposes of routine examination of spices, coffee, cocoa, starches, etc. The

water-mounted slide has proved in most cases to be best fitted for showing up the structural characteristics of this class of foods under the microscope, partly by reason of the fact that water rather than any other medium serves best for the rubbing-out process between the thumb and finger, whereby the sample on the slide is brought to any degree of fineness desired. Such a temporary method of mounting, however, presents many difficulties from a photographic point of view. The vibratory motion of the particles is very annoying, and some skill is required in using just the right amount of water, in avoiding air bubbles, in waiting the requisite amount of time for the vibratory motion to cease, and, on the other hand, in avoiding too long a delay, which would result in the evaporation of the water, and the consequent breaking up of the field. In the writer's experience, however, in spite of these difficulties, the water mounting gives decidedly the clearest results, and, with patience on the part of the operator, it is in many ways the most desirable method of mounting for the purpose of photographing. It in fact is the method employed in making most of the accompanying photo-micrographs, though a very few specimens were mounted in gelatine, and the subjects of the polarized light pictures in Canada balsam.

For purposes of examination of spices, starches and similar powdered food substances, the best results have been attained by using a combination of a one-sixth inch objective and a medium ocular, giving a magnification of from 240 to 330 diameters.

Experience has shown that two degrees of magnification well calculated to bring out the chief characteristics of the spices and their adulterants in a photo-micrograph are 125 and 250 diameters. The starches, which are the most common of any one class of adulterants, vary very widely in the size of their granules. With these the larger magnification of 250 has been found satisfactory, while the general appearance of the composite ground spice itself under the microscope, as well as that of such adulterants as ground bark, sawdust, chicory, pea hulls and the like, is best shown with the lower power of 125.*

The object mounted in the manner above described is best examined when held in a mechanical stage, furnished with micrometer adjust-

* One hundred and twenty-five and 250 are, accordingly, the degrees of magnification adopted in the originals of most of the photo-micrographs illustrated in the accompanying plates, but in the process of lithographing the photographs were slightly reduced, so that the actual scales in the reproduction are 110 and 220 respectively.

ments in such a manner that a typical field may be selected and held in place long enough to photograph.

The camera employed was the vertical variety of Bausch & Lomb make, on the base of which the microscope with any particular field desirable to photograph could be readily placed and quickly connected by means of a light-tight sleeve with the front board of the bellows without disturbing the adjustments. The camera was kept in a dark room, where the exposures were made, the source of light being a 16 or 32 candle-power electric lamp, preferably provided with a ground-glass bulb. The light from this lamp was carefully centred by moving the reflector of the microscope, and the final focusing was accomplished by the fine screw of the microscope, using a magnifying glass to obtain the best focus on the back plate of the camera, the ground glass of which was provided with a clear, central portion for the purpose.

In making pictures, for instance, of the larger magnification of 250 diameters, the Zeiss D objective, having an equivalent focus of one-sixth inch, was used in combination with the No. 3 ocular, with the ordinary tube-length of microscope. For the lower power, namely, 125 diameters, the same objective was employed, but the eye piece was left out, it being found necessary in this case to remove the upper tube of the microscope which ordinarily carries the eye piece, as otherwise the size of the field to be photographed would be restricted. In each case a diaphragm was used in the microscope stage, having an opening of about the same size as that of the front lens of the objective. By means of a stage micrometer scale, the proper position of the camera back is previously determined, to give the required magnification.

The small number of photo-micrographs that have appeared in former reports were made with a magnification of 150 diameters, but this scale is so near 125 that the difference is not especially marked.

It is extremely difficult to describe, even with the aid of illustrations, the actual microscopic appearance of such a composite substance as a ground spice, for example. The most striking characteristics seem to vary with different observers, and it is a well-known fact that authorities differ widely as to the size, shape and ordinary appearance, even in the case of certain of the well-known starch grains. The only reliable method seems to be for the analyst to provide himself with as complete a set of samples as possible of

starches and other adulterants of known purity, as well as of the pure foods themselves, and to familiarize himself thoroughly with their microscopic appearance under different conditions, keeping them in a convenient place for quick reference and comparison whenever necessary.

Starches.

Very small amounts of starch are readily identified in powdered mixtures by applying a drop of a solution of iodine to the object previously rubbed out with water on a slide under a cover glass. The starch granules, if present, will be at once colored intensely blue by the iodine, and are rendered apparent even when few in number by examination under the microscope.

Wheat Starch (Fig. 2). — This starch is very commonly used as an adulterant of mustard, ginger, cocoa, coffee and other foods. Its granules are circular disks, occurring for the most part in two sizes, of which the larger vary from .021 millimeter to .041 millimeter in diameter, while the smaller average about .005 millimeter. The smaller granules are grouped irregularly in and around the larger, there being six to ten of the former to one of the latter. The larger granules are, however, the most distinctly characteristic, and are usually readily recognized in a mixture, not only by their shape, but by reason of the concentric rings with which they are provided, and which are generally but not always apparent.

Barley Starch (Fig. 3). — This much resembles wheat, in that it has two sizes of circular granules, but both sizes are respectively smaller than those of wheat, though present in about the same proportion. The larger granules vary from .013 millimeter to .035 millimeter in diameter, while the smaller average .003 millimeter. The concentric rings are less apparent in the barley than in the wheat.

Rye Starch (Fig. 1) has also two sizes of circular disk-like granules, but the larger vary from .025 millimeter to .05 millimeter in diameter, and are considerably larger than the corresponding wheat granules. The smaller granules average about .004 millimeter in diameter. There is also a much larger proportion of small granules present than in the case of wheat. The concentric rings are often very distinct in the large rye starch grains, and many of these show cross-shaped rifts in the centre.

Corn Starch (Fig. 5). — This starch is a common adulterant of spices, cocoa and other foods. It is placed in a series of four cereal

starches whose granules are polygonal, and all of which show more or less tendency to arrange themselves in close contact side by side in masses suggestive of a tesselated or mosaic floor. Arranged in order of the size of their grains, these starches are: corn, oats, buckwheat and rice. Corn starch granules tend toward the hexagonal in shape, varying from .007 millimeter to .023 millimeter in diameter, and having very marked rifted hila. They are most readily recognized in any mixture, and from their size are readily distinguishable from the other polygonal starches.

Oat Starch (Fig. 4). — The granules of this starch, averaging .004 millimeter in diameter, are less regular in shape than the corn, besides being smaller. They have no rings or hila, and arrange themselves in little groups or masses that at first sight might be mistaken for large grains; careful examination, however, shows the dividing lines.

Buckwheat Starch (Figs. 6 and 7). — This is a very common adulterant of many spices, especially pepper, which, as shown in Fig. 48, it much resembles in the manner in which its aggregate masses of granules group themselves. The individual granules are quite uniform in size, averaging about .006 millimeter in diameter, and the masses are usually with difficulty broken up into individual grains, requiring considerable rubbing out under the cover glass.

Rice Starch (Fig. 8). — The granules of rice starch are considerably smaller than those of buckwheat, and are readily distinguished from the latter also by reason of the fact that they are much more sharply pointed (having less obtuse angles), and are grouped in smaller masses.

Starches of the Pea and Bean. — The starches of these legumes much resemble each other, and are with difficulty distinguished one from the other (see Figs. 9 and 10). The granules are more nearly oval than most other starches, and have both concentric rings and very marked hila. The starch of the pea is perhaps more regular and uniform in the size and form of its granules than that of the bean. Both peas and beans roasted are commonly used as adulterants of coffee.

Arrowroot. — There are many varieties of this starch, including Jamaica, Bermuda, East Indian, Australian and many others, all having certain variations in form and size, but resembling each other in a general way. Fig. 11 shows the Bermuda arrowroot, the

granules of which are somewhat egg-shaped, being usually smaller at one end than the other, and having rifted hila near the small end.

Potato Starch (Fig. 12). —This starch has large, irregularly oval granules, with very apparent hila situated eccentrically near one end, and with rings around the hilum. The granules are often .07 millimeter in large diameter. Figs. 13 and 14 show corn and potato starch when viewed with polarized light with crossed Nichol prisms, the specimens being mounted in Canada balsam.

Tapioca Starch. — The granules of this starch, as shown in Fig. 15, are more uniform in size throughout than those already described, averaging about .018 millimeter in diameter, and being quite smoothly circular, without concentric rings, but having a distinctly dotted hilum in the centre. Many of the grains are cup-shaped, as if a segment of the circle had been removed.

Sago Starch (Fig. 16). — The granules of sago starch vary much in size, and might be called irregularly ellipsoidal in shape, being provided with numerous protuberances. Some of them have indistinct concentric rings, and in some, but not all, a hilum is apparent, usually near one end of the granule.

Adulterants Other than Starches.

Under this head are included barks of various kinds, ground woods, ground fruit stones, especially those of the olive and date, nut shells, pea hulls, chicory and charcoal. Plates V. and VI. show some of these taken from samples of the adulterants themselves, while others appear in illustrations of some of the typically adulterated spices in the plates that follow, and are best described in connection with the spices in which they occur as adulterants.

Coffee (Fig. 22, Plate VI.). — A very characteristic bit of the tissue is here shown, consisting of a loose mesh of irregular hexagonal cells, thick-walled, and enclosing oil drops with amorphous material. In the ordinary sample powdered fine enough for microscopical examination it is not common that so large a section of this mesh work is apparent as Fig. 22 shows, but more often the hexagonal cells are shown in fragments, while here and there will be seen the slender, elongated, sharp-pointed cells of the outer skin of the coffee berry, not shown in the figure.

Fig. 23 shows a coffee adulterated with roasted peas and pea hulls. The roasting of the peas to some extent changes the appearance of the

starch grains, which, as found in coffee, commonly occur in masses containing from twenty to thirty granules of brownish color, sometimes showing very sharp markings and hila. In fact, the process of roasting tends to intensify the characteristics of the pea starch.

Fig. 21 shows large masses of ground pea hulls. The structure of the hulls of peas, beans and other legumes is very peculiar, being likened by some in appearance to palisades. They show regular billets, arranged much like bunches of matches, and are very clearly represented in Fig. 23; no genuine coffee whatever appears in this field.

Chicory. — This common adulterant shows to good advantage in Fig. 24, which is taken from an adulterated coffee. Chicory alone appears in this field. It is a mass of confused cellular tissue, which as here shown is traversed by two bright bands with striking transverse markings. These bands are the juice ducts. This figure should not perhaps be considered strictly typical, in that ordinarily the juice ducts appear in the powdered sample in more fragmentary form under the microscope rather than in large aggregate masses as here shown.

Cocoa. — Fig. 25 shows the microscopical appearance of a genuine powdered cocoa, which consists of a loose mass of yellowish-brown matter, containing small variously sized starch granules and small globules of oil. The most common adulterants of cocoa to be recognized under the microscope are corn starch (Fig. 5), wheat starch (Fig. 2) and arrowroot (Fig. 11). Fig. 26 shows a cocoa adulterated with arrowroot.

Allspice. — Fig. 27 shows pure allspice. There are three distinctive features especially typical of allspice under the microscope. First, the starch grains, which are very uniform in size, being nearly circular, as a rule, and often arranged in groups not unlike the masses of buckwheat starch already described. Ordinarily these masses contain fewer granules than do those of buckwheat; the granules are smaller and more inclined to the circular than to the polygonal form, while in many cases they have distinct central hila. A second distinctive feature of allspice is the stone cells, of which there are many. These are shown very plainly in Fig. 28. The third and most characteristic feature of the allspice under the microscope is the striking appearance of the lumps of gum or resin which it contains in considerable quantity. These lumps are of a

port wine or amber color, occurring sometimes in isolated bits and in other cases in aggregations of from two to four or even six or eight drops or lumps. The color of these lumps of gum is very striking and unmistakable.

Fig. 28 shows an allspice adulterated with cayenne pepper. On one side of the field is a small aggregation of the lumps of gum already described, with a single stone cell above it, while on the other side is a large bit of inner skin of the capsicum.

Cassia. — Plate VIII. shows the appearance of ground cassia under the microscope. The starch of cassia slightly resembles that of allspice, but it is not found, as a rule, in masses containing as many granules as does the allspice starch. More commonly two or three of the starch granules are arranged together in such a manner that at first sight they appear to form a single granule, but on a more careful view are seen to be two and three lobed, consisting of several smaller grains. Stone cells are also very common in powdered cassia, though these are not especially apparent in the three figures of Plate VIII. The cassia stone cells are commonly more oblong than those of allspice. Cassia stone cells are more often brown in color, while the allspice stone cells are generally gray or colorless.

Another feature of powdered cassia is the long bundles of amber-colored wood fibre, loosely held together; also yellow patches of cellular skin with starch grains as a rule in and among them.

Fig. 32 shows a cassia adulterated with a mass of foreign bark. Various ground barks of the commoner trees, especially that of the elm, resemble in some degree the cassia bark, but one point of difference can be detected almost invariably. The fibres of the cassia bark have a large number of starch grains interposed among them, which are plainly to be seen, while the foreign bark is usually of a coarser grain, and shows no starch granules intimately connected with it.

Cayenne. — Figs. 33 and 34 show the appearance of powdered cayenne under the microscope. Pure cayenne contains no starch. The two kinds of skin, the inner and the outer, are both shown in Fig. 34, while Fig. 33 shows a large mass of the outer skin only. The inner skin has striking markings not unlike the convolutions of the intestines. The yellow droplets of oil distributed through the field are very characteristic of cayenne. Fig. 36 shows a cayenne

adulterated with corn starch and red sandalwood. The latter is a very common adulterant, but unless used in moderation it gives a deep and artificial color to the powder. Its brilliant color when viewed through the microscope is very striking.

Wheat, corn and nut shells are shown in Figs. 35 and 36, which represent adulterated cayenne. A small mass of capsicum skin is shown near the edge of the field in Fig. 35.

Cloves. — Of all spices, powdered cloves has a less distinctive appearance than any other when seen under the microscope. The general appearance of the cellular tissue of the clove is that of a loose, spongy mass, filled with brown granular material, and, when carefully rubbed out under the cover glass, not too dense to be readily seen through. Throughout the masses of tissue are to be seen small oil globules. Fig. 37, Plate X., illustrates a typical mass of powdered clove.

Genuine powdered clove should show but few stone cells and no starch. If a large number of stone cells appear, this in itself is evidence of adulteration. Common adulterants of cloves are clove stems, various starches already described, and ground nut shells, especially those of the cocoanut. Slender rods sharpened at both ends characteristic of clove stems are not here illustrated, nor are the spiral ducts which are also often found.

Figs. 38 and 39 show samples of clove adulterated with cocoanut shells. Near the centre of the field in Fig. 39 a mass of pure clove tissue appears.

With spices such as clove, that contain essential oil, a microscopical examination should be supplemented by a chemical analysis. The ether extract should at least be taken, if there is reason to suspect the removal of part of the essential oil. Exhausted cloves (*i.e.*, cloves from which a part of the oil has been removed) are by no means uncommon.

Ginger. — Fig. 40 shows the starch granules of pure ginger with the surrounding cell walls, and Fig. 41 the ginger starch alone.

The granules of ginger starch are ellipsoidal, and as a rule very clear and transparent, being for the most part entirely devoid of either hilum or concentric rings. Occasionally granules are to be found, however, with faint concentric markings and even with an apparent hilum. The characteristic form of the ginger starch granule is more or less egg-shaped, with a small protuberance near one

end. This protuberance serves to readily distinguish the starch granules of ginger from those of wheat, with which ginger is frequently adulterated. While wheat granules are of various sizes, the grains of ginger starch are as a rule much more uniform.

Other adulterants of ginger, besides wheat, are corn, rice, sawdust and turmeric. Fig. 42 shows ginger adulterated with turmeric. The large mass extending through the centre of the field is an aggregation of the starch grains and fibres of turmeric, and several isolated starch granules are found distributed through the field. Turmeric masses have a very brilliant yellow appearance under the microscope. The starch granules of turmeric are somewhat difficult to separate from the masses, but when shown individually are shaped somewhat like clam shells, and have very deeply marked rings. Care should be taken to distinguish between the wood fibre natural to the ginger root and sawdust of soft wood, which is a common adulterant. A careful study should be made of ground sawdust, with its long spindle cells and lateral pores, as shown in Fig. 18, and the wood fibre of the genuine ginger root. A careful examination will nearly always disclose the presence of a large number of ginger starch granules in close connection with the genuine root fibre.

Fig. 44 shows a ginger adulterated with wheat bran.

Mustard. — The appearance of pure ground mustard is clearly shown in Fig. 45. This is a photo-micrograph of the ground hulled seed without extraction of the oil, and should not, therefore, be taken as a standard for commercial mustard "flour," from which as a rule a large portion of the oil has been removed. The cellular tissue of the mustard shows in the form of granular masses of loose fine gray texture; the globular bodies are oil drops. Here and there through the masses of ordinary ground mustard are to be seen patches of yellowish seed skin, a mass of which is shown in Fig. 47, with dark-brown spots distributed regularly through it. This is a bit of one of the layers or coatings (of which there are several) that form the hull of the seed. Another form of mustard hull is similar in appearance, having the dark-brown spots, but the background is nearly colorless instead of yellow. It is difficult to draw the line between the amount of mustard hulls which may naturally exist in ground mustard and the excess amount which is sometimes added in the form of an adulterant. Samples in which these patches of hulls

predominate in number over the regular cellular tissue of the seed are undoubtedly adulterated by the fraudulent admixture of ground hulls (see page 666, Food and Drug).

The most common adulterants of mustard other than excess of hulls are wheat, turmeric and rice. Certain of the yellow aniline colors are occasionally employed to give an artificial yellow, the dye being sometimes of the variety which colors the mustard oil. If this variety of dye has been employed, the oil globules under the microscope will show a much deeper yellow or orange than in the case of pure mustard.

Pepper. — Fig. 48 shows the characteristic aggregations of pepper starch, magnified 110 diameters; and Fig. 49 shows the starch granules at a magnification of 220. The tendency of pepper starch to group itself into masses, as shown in Fig. 48, is very marked. The most common adulterant of pepper is buckwheat starch (see Figs. 6 and 7, Plate II.). The starches of pepper and of buckwheat much resemble each other in microscopical appearance, as will be seen by careful comparison of the figures. The shape of the starch grains is polygonal in both cases, and the masses into which they group themselves are very similar. In point of size, however, the buckwheat starch grains are considerably larger than those of pepper, and this is true also of the aggregate masses. The individual granules of pepper starch average .003 millimeter.

Other characteristics of ground black pepper are the stone cells (not shown in the figure), and occasional patches of the skin. A large excess of the brown stone cells in the powdered pepper indicates the fraudulent addition of pepper shells, — a not uncommon form of sophistication.

Fig. 50 shows pepper adulterated with wheat and cayenne. A common adulterant of pepper is ground olive stones. These are shown alone in Fig. 19, Plate V., while Fig. 52, Plate XIII., shows a sample of pepper largely adulterated with the olive stones, the adulterant being the chief feature of the picture. Wheat, corn and rice are shown in an adulterated pepper of which Fig. 53 is a photograph; while wheat and buckwheat appear in Fig. 54.

Nutmeg. — Fig. 55 shows a genuine ground nutmeg, the structure of which appears as a loose mesh work of bruised or broken cellular tissue, containing circular starch granules with central hila.

In examples heretofore cited dry powders have been the subject of examination. In Plates XIV. and XV., however, are shown the application of the microscope to the examination of fat.

Lard. — The presence of beef stearine in lard is often somewhat difficult to prove. The butyrorefractometer reading, the iodine number, the saponification equivalent and other chemical tests need often to be confirmed by the actual microscopical detection of the stearine crystals in a mixture.

The Preparation of the Lard Sample for Microscopic Examination. — From two to five grams of the fat are dissolved in 10 to 20 cubic centimeters of ether, or preferably in a mixture of equal parts of ether and alcohol, in a test tube, and the solution allowed to stand a few hours or over night, the test tube being loosely stoppered with cotton. The crystals obtained vary considerably with the condition of heat, amount and kind of solvent, rate of crystallization, etc., so that the operator had best vary these conditions till he is satisfied that the best possible results have been obtained. It is often advantageous to separate the crystals first obtained by filtration from the mother liquor and to redissolve in ether or mixed ether and alcohol and recrystallize in a second test tube. The crystals formed at the bottom of the test tube are removed for examination by the aid of a piece of small glass tubing acting as a pipette, inserted carefully in the test tube and closed by the finger in such a manner that when drawn out it will withdraw some of the crystals in the surrounding liquid. These are then transferred to a microscope slide, a cover glass is placed on them, and the specimen is examined under various powers of the microscope.

Fig. 56 shows the typical appearance of pure lard stearine from a leaf lard of known purity, and Figs. 57 and 58 illustrate beef stearine. These figures show distinctive crystallization of each form under the best conditions. The lard stearine crystals when thus obtained are flat rhomboidal plates cut off obliquely at one end, and, as shown in Fig. 56, are grouped irregularly, as if thrown carelessly together. The beef stearine crystals, on the other hand, are cylindrical rods or needles, often curved, with sharp ends, and are arranged as shown in fan-shaped clusters. Conditions of crystallization are frequently such as not to show the sharp distinctions noted above. Both forms of crystals are at times apt to gather in clusters that at first sight appear somewhat similar, and are often misleading

as to their true character (see Figs. 59 and 60). It is found almost invariably that the beef stearine crystals gather in clusters radiating from a common centre or point, often with a peculiar twisted appearance, breaking up into little fans. Lard crystals, it is true, do not always lie flat in irregular groups as shown in Fig. 56, but, as in Fig. 59, form clusters that unless studied carefully might at first sight be considered as identical with the fan shapes of the beef stearine already described. It will be seen, however, that if the best possible conditions are attained, the crystals of lard, instead of radiating from a point, are arranged more like feathers or alternate leaves on a branch, each crystal being given forth from another close at hand. Moreover, the lard crystals are themselves straight and not curved, the apparent curve in the appearance of the clusters being, on careful examination, especially under high power, seen to be chiefly due to several of these straight crystals arranged at angles to each other.

Even when the highest powers of the microscope are applied to the beef stearine crystals, they will always appear as cylindrical, sharp-pointed rods, some straight, others curved; while with the lard crystals they should be capable of showing the thin, flat, oblique-ended structure when examined with higher powers, even when they are arranged in the feathery clusters, the apparently pointed ends of some of the crystals being due to the fact that the plates are viewed edgewise. This is apparent in Fig. 60, in which the crystals are magnified to 480 diameters.

It is frequently necessary to make several repeated crystallizations under varying conditions before satisfactory results are arrived at. It is difficult to detect with confidence as small an admixture as 10 per cent. of beef fat in lard by the microscope test alone.

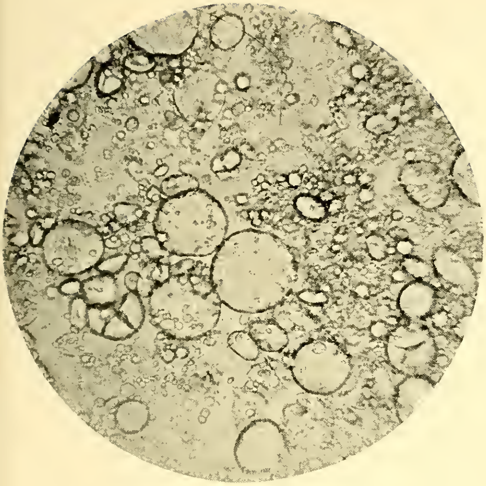

Fig. 1.—Rye Starch, x 220.

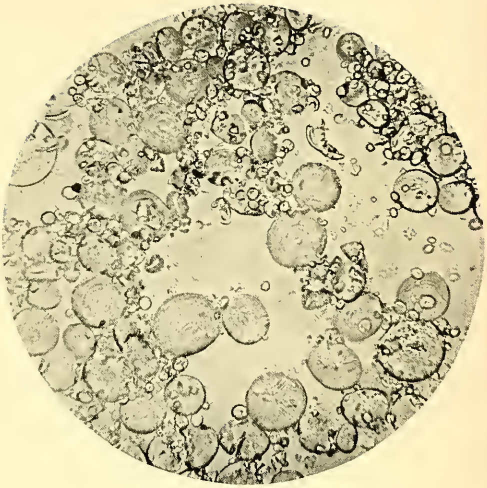

Fig. 2.—Wheat Starch, x 220.

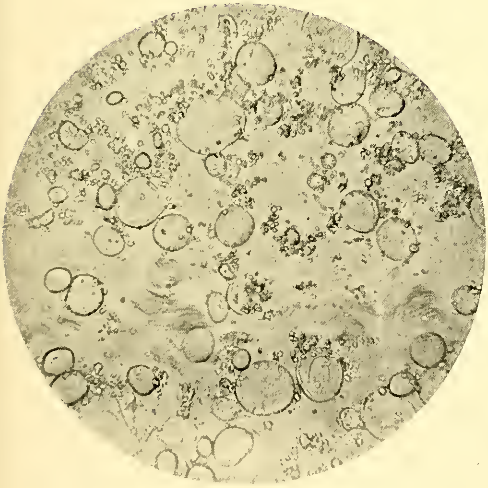

Fig. 3.—Barley Starch, x 220.

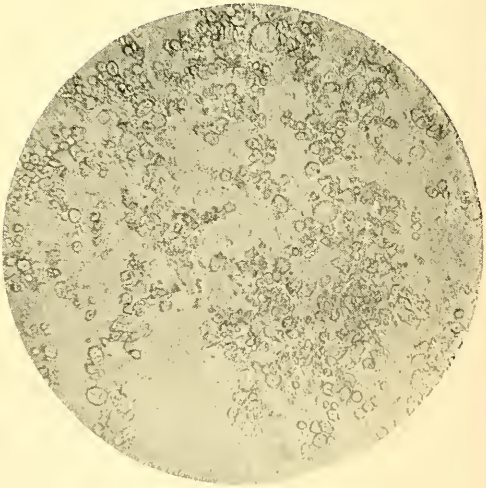

Fig. 4.—Oat Starch, x 220.

Plate I.

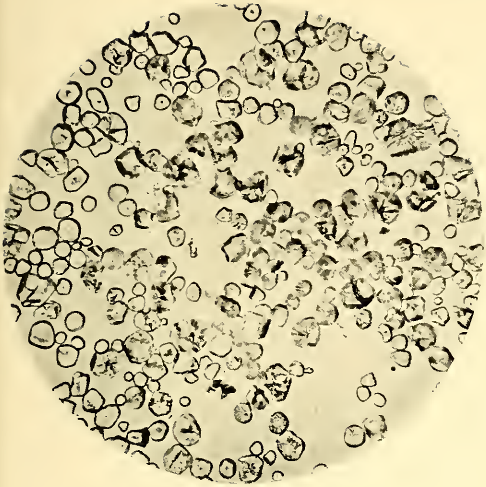

FIG. 5.—Corn Starch, x 220.

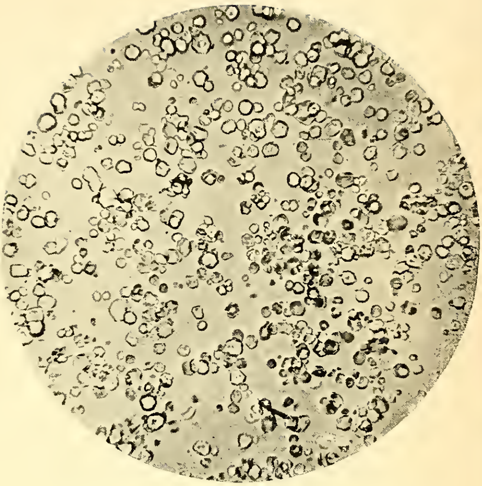

FIG. 6.—Buckwheat Starch, x 220.

FIG. 7.—Buckwheat Starch Masses, x 110.

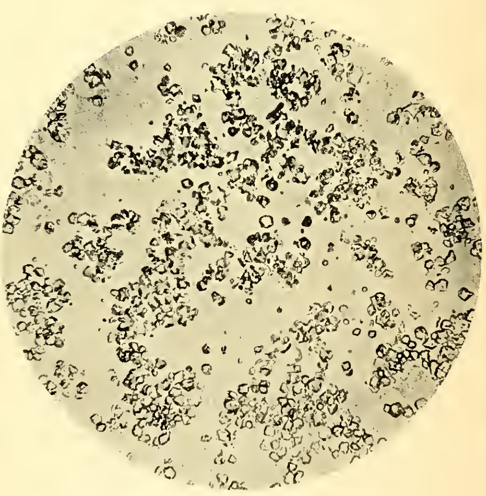

FIG. 8.—Rice Starch, x 220.

Plate II.

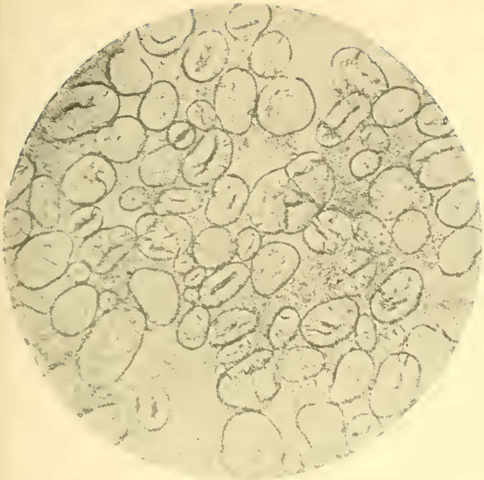

FIG. 9.—Pea Starch, x 220.

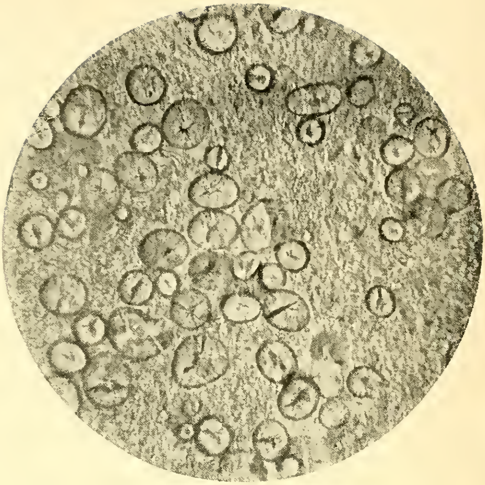

FIG. 10.—Bean Starch, x 220.

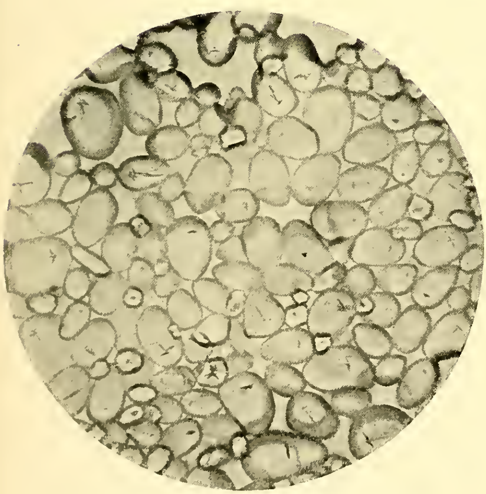

FIG. 11.—Arrowroot Starch, x 220.

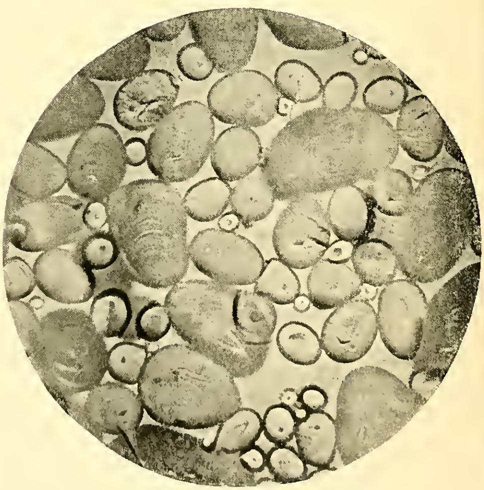

FIG. 12.—Potato Starch, x 220.

Plate III.

FIG. 13.—Corn Starch (Polarized Light), x 220.

FIG. 14.—Potato Starch (Polarized Light), x 220.

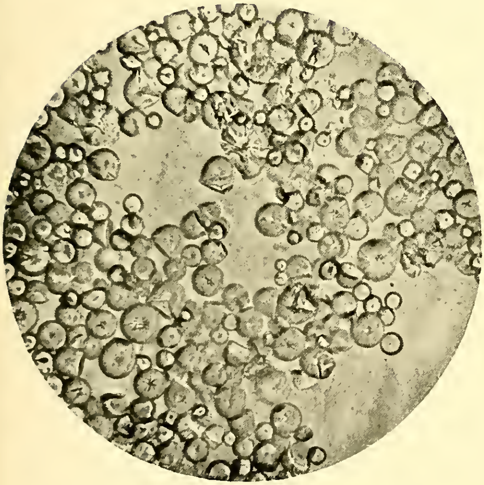

FIG. 15.—Tapioca Starch, x 220.

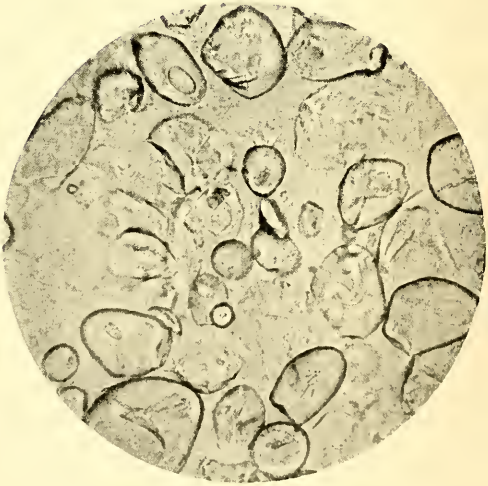

FIG. 16.—Sago Starch, x 220.

Plate IV.

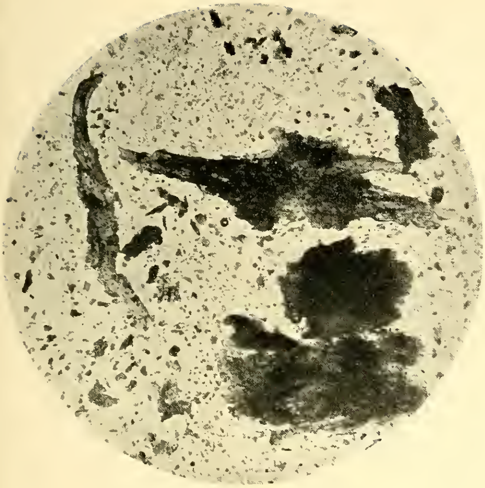

FIG. 17.—Elm Bark, x 110.

FIG. 18.—Sawdust, x 110.

FIG. 19.—Olive Stones, x 110.

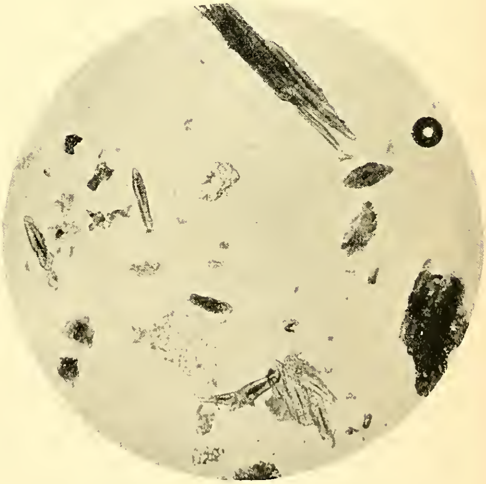

FIG. 20.—Cocoanut Shells, x 110.

Plate V.

FIG. 21.—Pea Hulls, x 110.

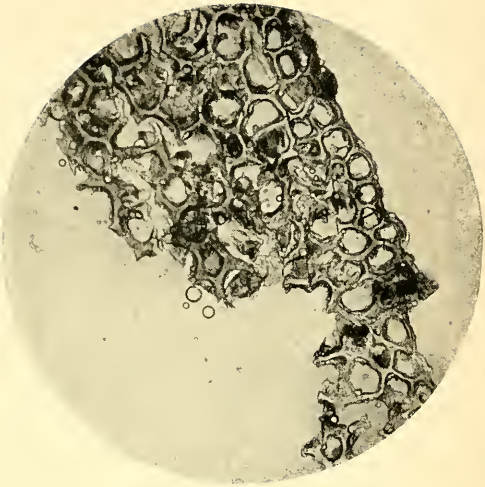

FIG. 22.—Pure Coffee, x 130.

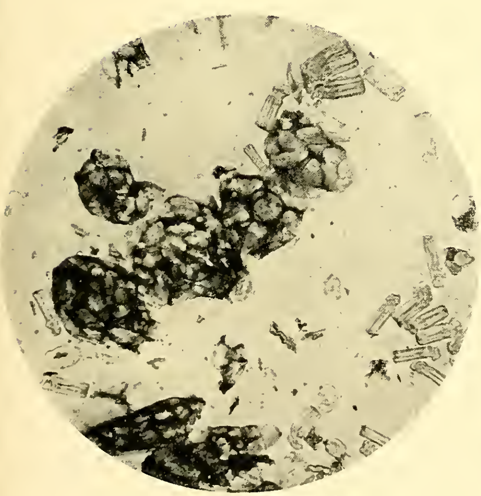

FIG. 23.—Coffee adulterated with Peas and Pea Hulls, x 130.

FIG. 24.—Chicory in an Adulterated Coffee, x 130.

Plate VI.

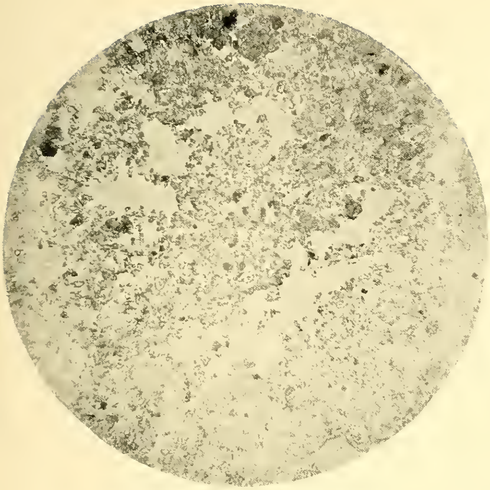

FIG. 25.—Pure Cocoa, x 110.

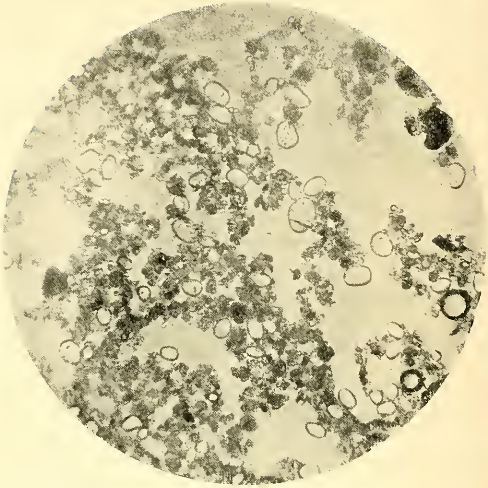

FIG. 26.—Cocoa adulterated with Arrowroot, x 110.

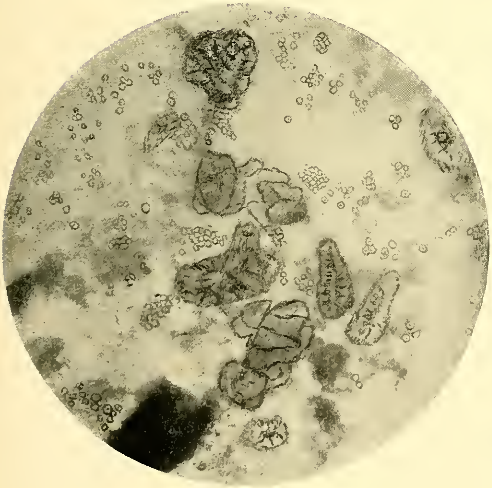

FIG. 27.—Pure Allspice, x 110.

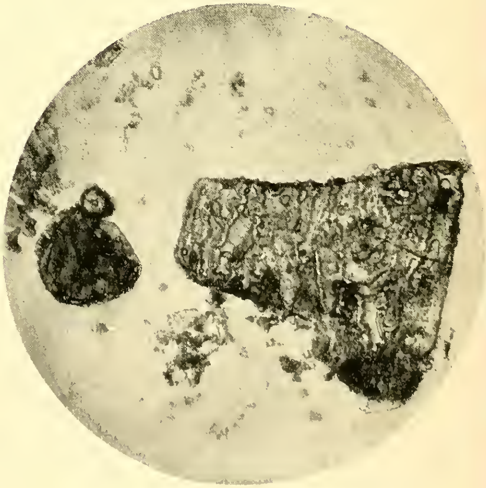

FIG. 28.—Allspice adulterated with Cayenne, x 110.

Plate VII.

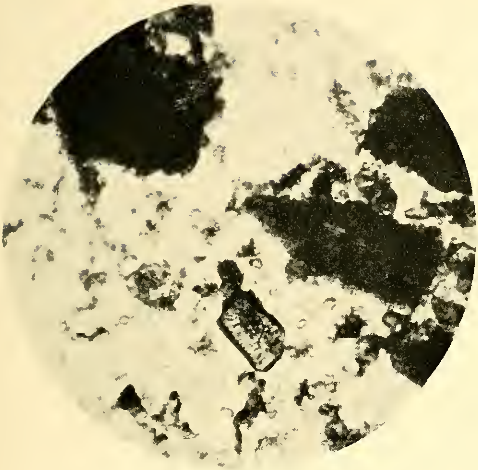

FIG. 29.—Pure Cassia Bark, x 110.

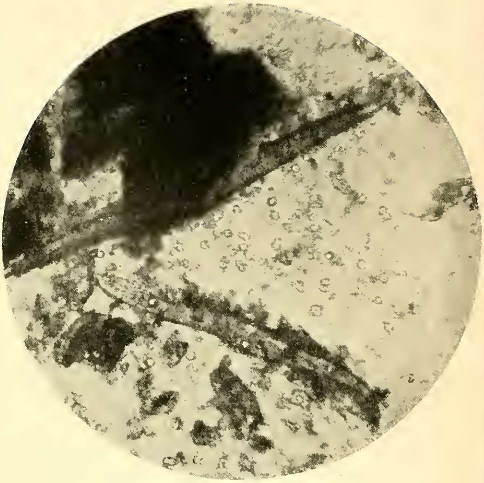

FIG. 30.—Pure Cassia Bark, x 110.

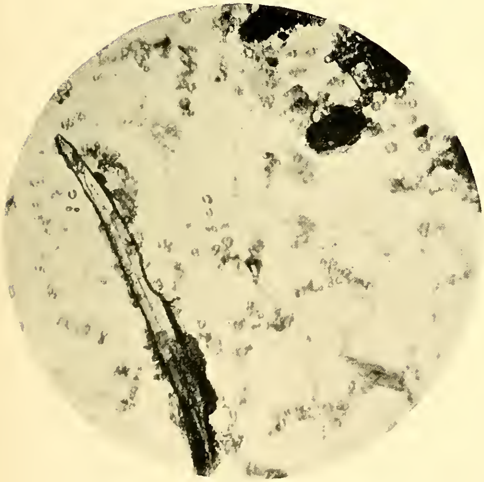

FIG. 31.—Pure Cassia Bark, x 110.

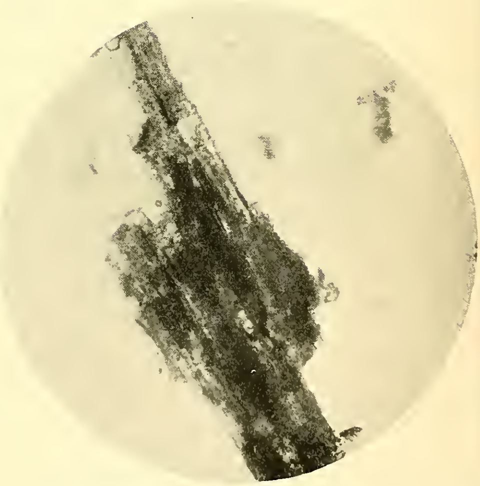

FIG 32.—Cassia adulterated with Foreign Bark, x 110.

Plate VIII.

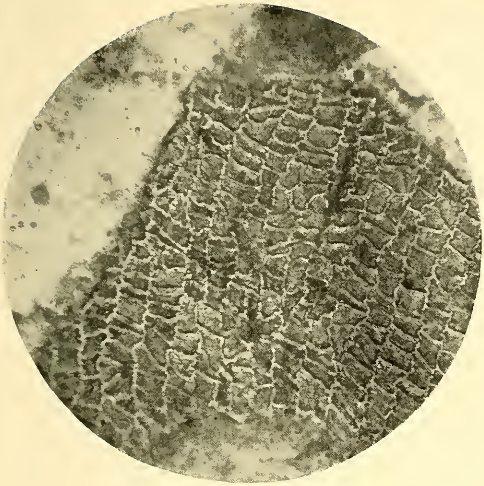

FIG. 33.—Pure Cayenne, x 110.

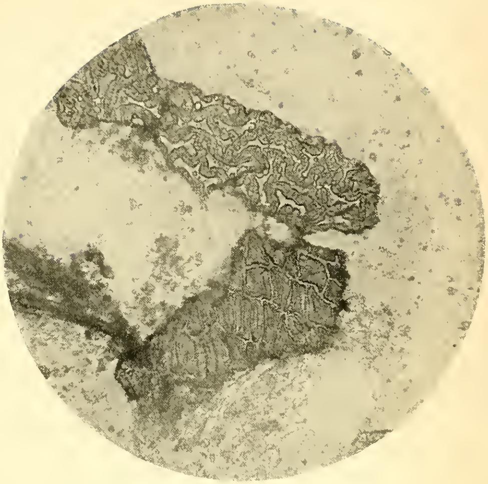

FIG. 34.—Pure Cayenne, x 110.

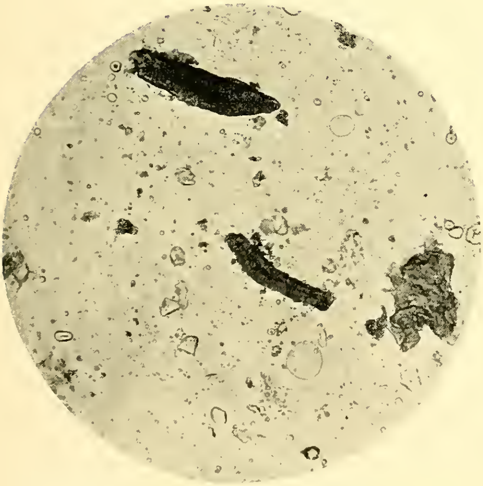

FIG. 35.—Cayenne adulterated with Wheat, Corn and Cocoanut Shells, x 130.

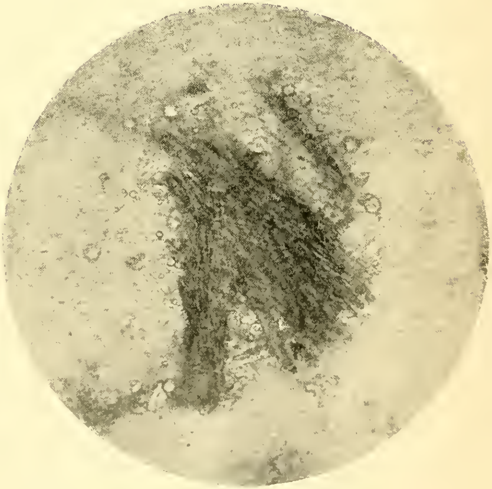

FIG. 36.—Cayenne adulterated with Corn and Redwood, x 110.

Plate IX.

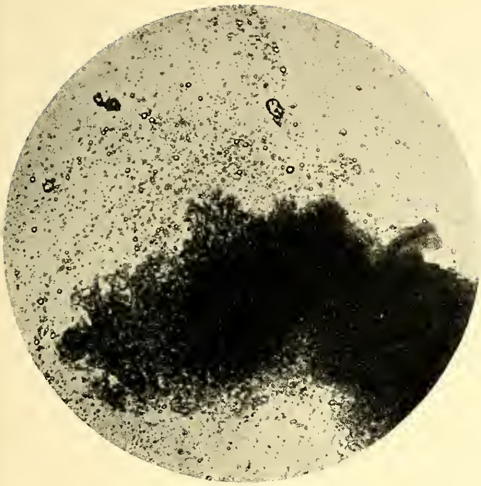

FIG. 37.—Pure Cloves, x 130.

FIG. 38.—Cloves adulterated with Cocoanut Shells, x 130.

FIG. 39.—Cloves adulterated with Cocoanut Shells, x 130.

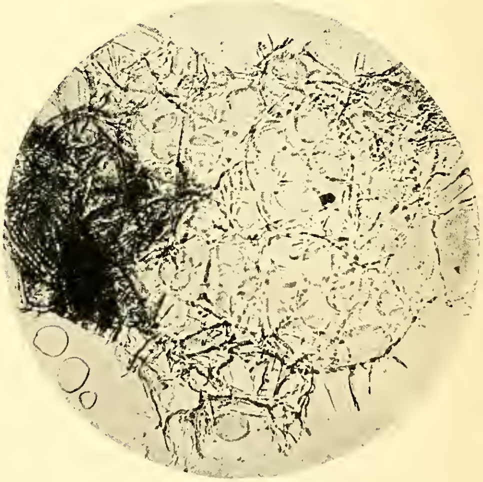

FIG. 40.—Pure Ginger Starch in Cells, x 220.

Plate X.

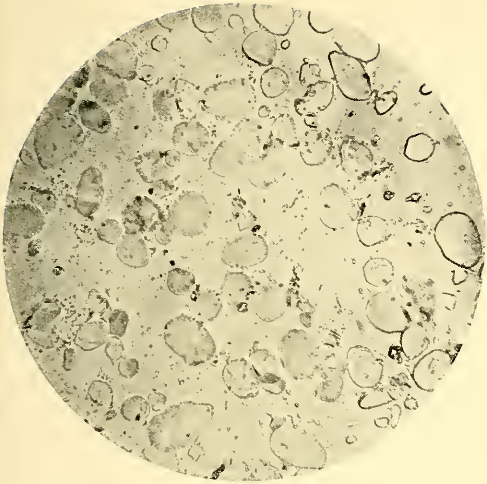

FIG. 41.—Pure Ginger Starch, x 220.

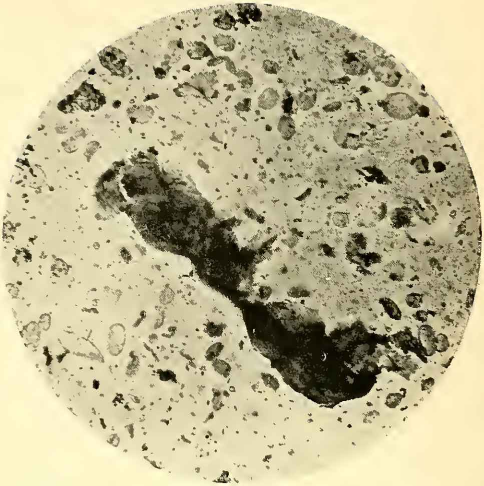

FIG. 42.—Ginger adulterated with Turmeric, x 130.

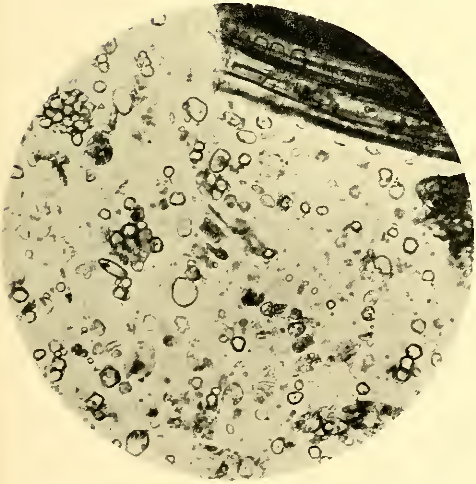

FIG. 43.—Ginger adulterated with Corn and Wheat, x 130.

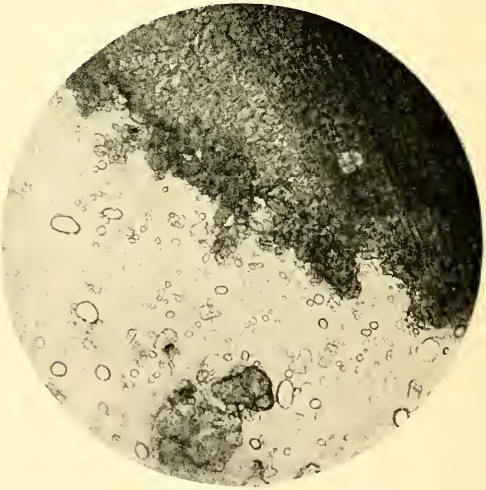

FIG. 44.—Ginger adulterated with Wheat Bran, x 130.

Plate XI.

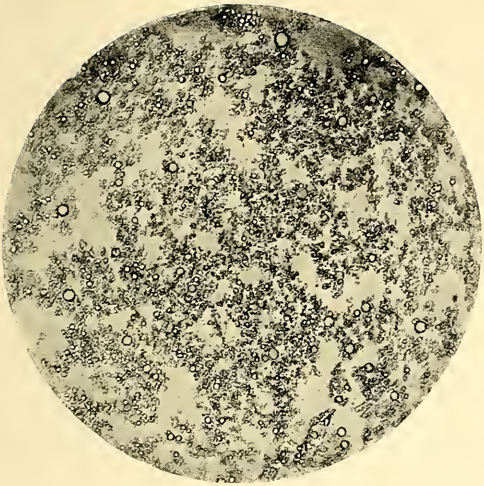

FIG. 45.—Pure Mustard, x 130.

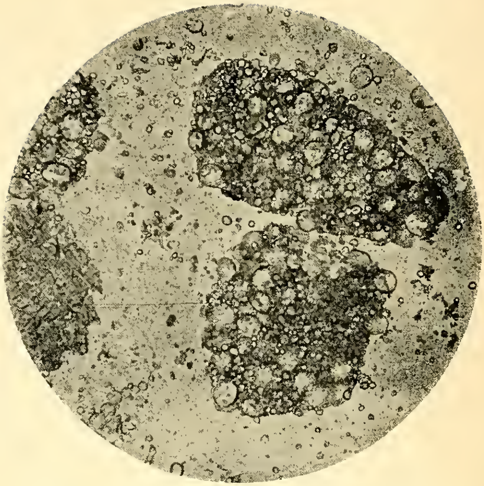

FIG. 46.—Mustard adulterated with Wheat, x 130.

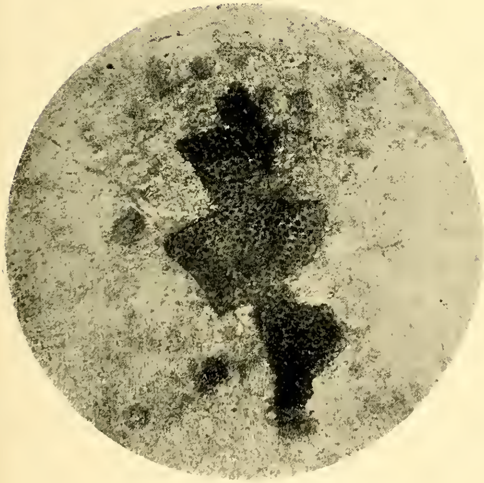

FIG. 47.—Mustard Hulls, x 110.

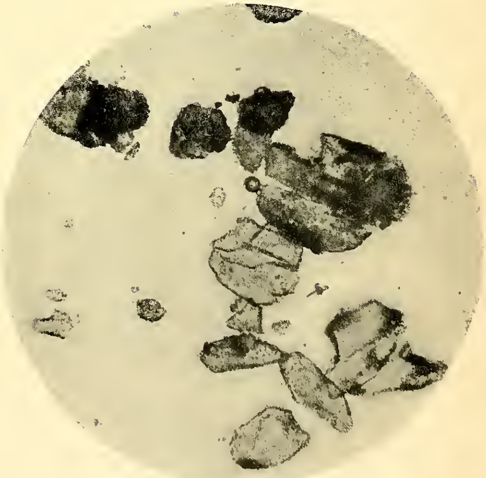

FIG. 48.—Pure Pepper Starch Masses, x 110.

Plate XII.

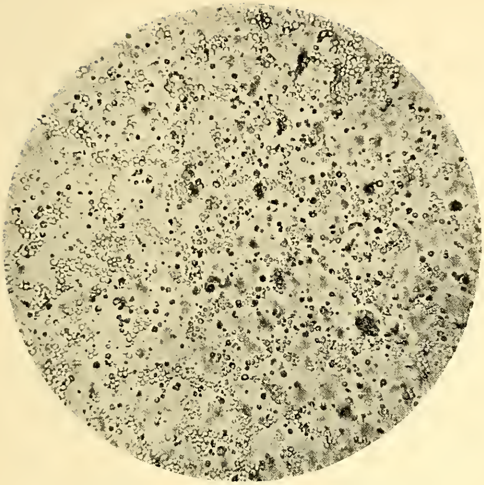

FIG. 49.—Pure Pepper Starch, x 220.

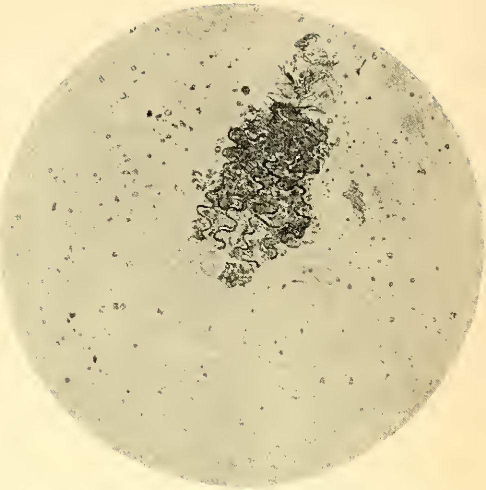

FIG. 50.—Pepper adulterated with Wheat and Cayenne, x 130.

FIG. 51.—Pepper adulterated with Buckwheat, x 130.

FIG. 52.—Pepper adulterated with Olive Stones, x 110.

Plate XIII.

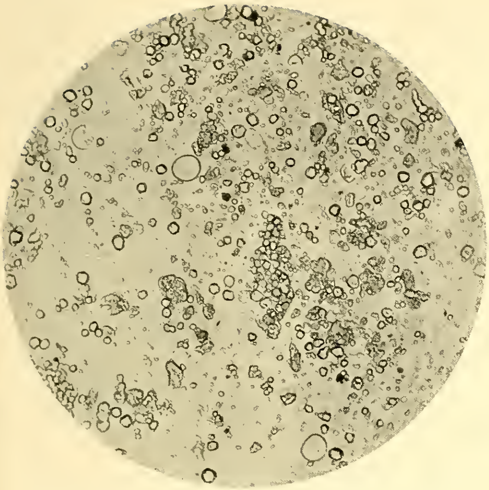

FIG. 53.—Pepper adulterated with Wheat, Corn and Rice, x 130.

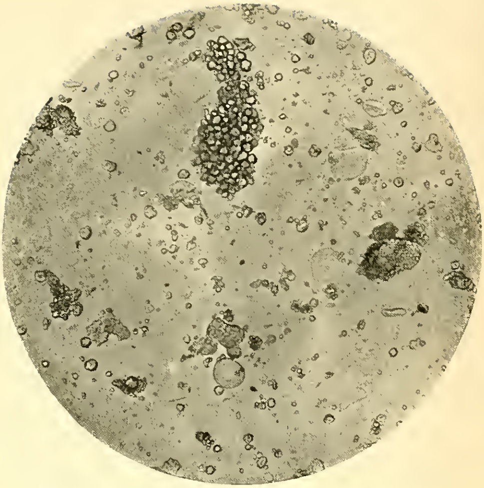

FIG. 54.—Pepper adulterated with Wheat and Buckwheat, x 130.

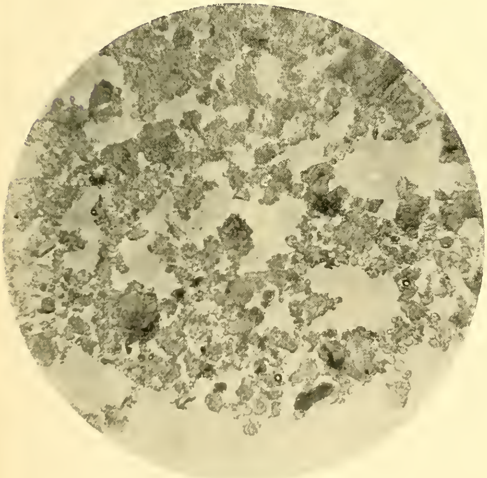

FIG. 55.—Pure Nutmeg, x 110.

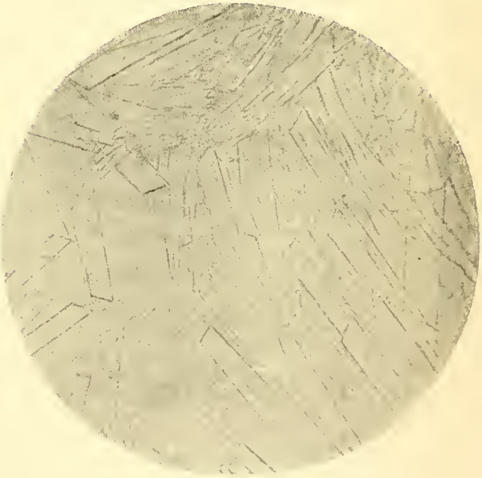

FIG. 56.—Pure Lard Stearine, x 220.

Plate XIV.

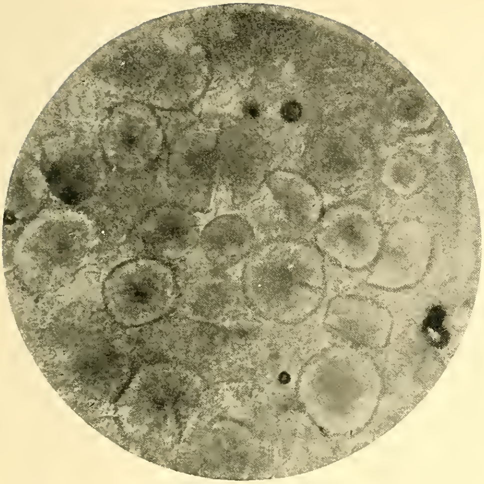

FIG. 57.—Beef Stearine, x 110.

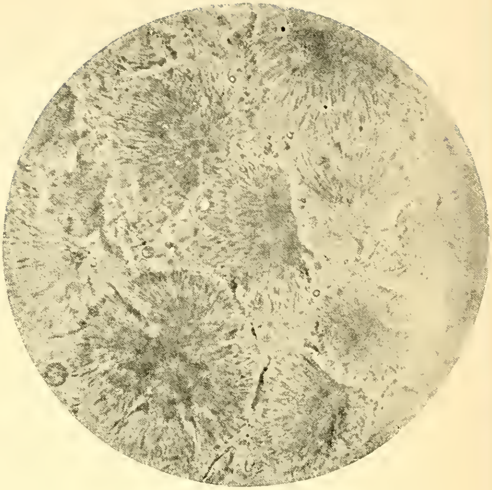

FIG. 58.—Beef Stearine, x 220.

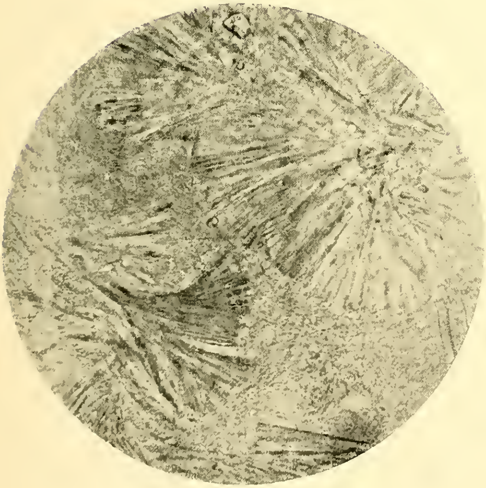

FIG. 59.—Lard Stearine, x 220.

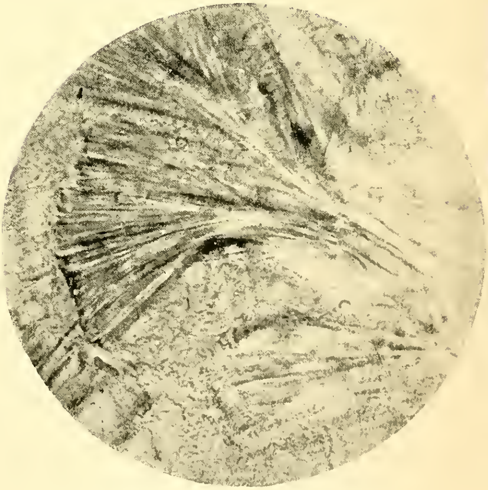

FIG. 60.—Lard Stearine, x 480.

Plate XV.

REPORT

ON

ARSENIC AND OTHER POISONS

IN

MANUFACTURED GOODS.

By ALBERT E. LEACH, *Analyst of the Board.*

REPORT ON ARSENIC AND OTHER POISONS IN MANUFACTURED GOODS.

By Albert E. Leach, *Analyst of the Board.*

A new law was enacted by the Legislature in 1900, fixing a standard for the amount of arsenic allowable in woven fabric or paper, and providing for a fine of not less than $50 nor more than $200 for any infringement of the law.[1] The State Board of Health was authorized, under the provisions of this act, to make the necessary investigation as to the existence of arsenic in the various materials provided for; and the food and drug department examined a large number of samples collected by one of its inspectors during the months of October, November and December, so as to ascertain the true state of the market, prior to the first day of January, 1901, when the act was to take effect.

Several investigations along these lines have been made in past years by this Board. As early as 1872 a thorough research was made by Dr. Draper,[2] again in 1883 by Dr. Wood,[3] and a third time by Dr. Hill in 1891.[4] It is believed that the present law is the first to be passed in this country fixing a legal limit for arsenic in goods of this class.

Since the earlier investigations of the Board, conditions as to the use of arsenic in wall papers, dress goods, etc., have considerably changed. Formerly the use of arsenical pigments was very common, and many of the brilliant greens found both in wall papers and in cloth consisted entirely of such pigments as Scheele's green and other arsenical colors; now, however, these pigments are almost never found, and arsenic is to be looked for at present in manufactured goods irrespective of color.

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[1] Chapter 325, Acts of 1900.

[2] Third annual report of State Board of Health, 1872, page 33.

[3] Fifth annual report of State Board of Health, Lunacy and Charity, page 213.

[4] Twenty-third annual report of State Board of Health, 1891, page 701.

Occurrence of Arsenic in Cloth and Paper. — There are three direct sources to which the occurrence of arsenic may be attributed: first, as the chief ingredient of the particular dye employed, as in the case of Scheele's and other arsenical greens already referred to; second, as an impurity incidental to the manufacture of the dye, as in magenta or fuchsine, when made by the so-called arsenical process; and third, as an ingredient of certain reagents used in the manufacture of cloth, whether as an impurity in the reagent or as an intentional ingredient therein.

Indigos and nearly all the sulphonated colors contain arsenic from the sulphuric acid used in their manufacture. In the manufacture of turkey red the arsenate of soda is still used in some places as a clearing bath after the mordanting and dyeing, the arsenate of soda taking the place of the old dung bath. It is more common, however, at the present time, to use sodium phosphate which often contains arsenic as an impurity, and it is a question whether or not this reagent does not furnish arsenic to the goods.

It is no doubt true that where arsenate of soda is still used in turkey red dyeing, the cloth is in many cases given such a severe after-treatment of washing, soaping, rubbing and beating, in order to make the color (formerly a dull red) more brilliant, that much of the arsenic is washed out.

Still another cause of the presence of arsenic is due to its use as an antiseptic. Many colors are sold to print makers in the form of paste, and arsenic is found to be a better preservative of these pastes than salicylic acid. Many sizing solutions used in the manufacture of paper and cloth, depending for their efficiency on starch, dextrine, etc., contain arsenate of soda to prevent fermentation.

Reporting Results. — Under the provisions of the law, manufactured articles are divided into two classes; first, paper and woven fabrics other than dress goods, in which the legal limit of arsenic is .1 grain per square yard; and second, dress goods and articles of dress in which the legal limit of arsenic has been fixed at .01 grain per square yard. It is to be noticed that the word "arsenic" is not qualified in any way in the wording of the act, so that technically metallic arsenic must be understood rather than arsenious oxide. For this reason the results have been recorded and reported as metallic arsenic rather than As_2O_3, though the latter was the

customary form in which arsenic was recorded in past investigations, and perhaps is the most natural.

It was thought best to discriminate between the samples that were absolutely non-arsenical and those in which arsenic was found, but in amounts below the legal limit; and in reporting the results, realizing that the common term "traces of arsenic" was too indefinite, the following classification was adopted: —

1. Arsenic below the legal limit, { Slightly arsenical. / Decidedly arsenical. }
2. Arsenic about the legal limit.
3. Arsenic above the legal limit.

In case of samples falling under the third class, the exact amount of arsenic was reported.

The general results of the investigation prior to January 1, 1901, are summarized as follows: —

Paper and Woven Fabrics Other than Dress Goods. (Legal Limit of Arsenic, .1 Grain per Square Yard.)

Character of Sample.	Number examined.	Number free from Arsenic.	Number containing Arsenic.		Grains per Square Yard in Highest Sample (As.).
			Above Legal Limit.	Below Legal Limit.	
Bed ticking,	14	14	–	–	–
Carpeting,	9	4	–	5	–
Colored paper for box covers,	20	18	–	2	–
Cotton drapery,	3	–	3	–	41.25
Crepe paper,	12	12	–	–	–
Upholstery goods,	29	23	–	6	–
Wall paper,	70	52	4	14	8.40
Summary,	157	123	7	27	41.25

Dress Goods and Articles of Dress. (Legal Limit of Arsenic, .01 Grain per Square Yard.)

Character of Sample.	Number examined.	Number free from Arsenic.	Number containing Arsenic.		Grains of Arsenic (As.) per Square Yard in Highest Sample.
			Above Legal Limit.	Below Legal Limit.	
Corduroy,	1	–	–	1	–
Cotton dress goods, prints, etc.,	73	44	6	23	1.206
Cotton linings, cambric, etc.,	22	21	–	1	–
Cotton, single color,	9	5	–	4	–
Cotton gloves, black,	2	–	–	2	–
Fancy sleeve and vest linings,	14	8	4	2	.402
Miscellaneous,	9	8	–	1	–
Silk ribbons,	11	11	–	–	–
Stockings, black cotton,	39	6	11	22	.147
Stockings, blue cotton,	1	–	1	–	.010
Stockings, brown cotton,	1	–	1	–	.010
Stockings, red cotton,	1	1	–	–	–
Stockings, blue woollen,	1	–	1	–	.010
Turkey red,	2	1	1	–	1.630
	186	105	25	56	1.630
General summary,	343	228	32	83	41.250

It should be stated that the highest figures given in grains of arsenic per square yard, opposite the headings "cotton drapery" and "wall paper," do not actually represent the present state of the market, for the reason that the samples showing these high figures were not goods on sale, but were furnished voluntarily through the courtesy of a dealer as examples of goods known to be colored with arsenical pigments. The maximum figures given, however, for prints and dress goods, sleeve linings, black stockings and turkey red, represent instances of goods actually bought in the market.

The general result of the investigation has been somewhat surprising, in that the extent to which arsenic was found to exist in goods sold throughout the State was on the whole smaller than was at first suspected. It should be remembered, however, that several months prior to the collection of these samples the circulars of the Board making known the provisions of the new law had been very widely distributed among the dealers in these goods throughout the

State, most of whom have co-operated with the Board in this work. Some of the larger dealers have, in fact, themselves sent out circulars to the manufacturers from whom they obtained their goods, notifying them of the provisions of the new law, and absolutely refusing to accept goods without a guaranty of their freedom from arsenic.

Some classes of goods wherein arsenic was least expected have been found to contain it in considerable quantities, as, for instance, black stockings, which were found to contain as high as .147 grains of metallic arsenic per square yard. Arsenic was also found in considerable quantity in a number of samples of fancy sleeve and vest linings, in which narrow stripes or dots, mostly of a blue color, were printed on a white ground. In the latter case the arsenic was probably attributable to the sizing used in the goods. In the case of black stockings, this class of goods is commonly dyed with the so-called sulpho-dyes, which are made by treatment of various nitro and amido bodies, such as nitro benzol, toluidine, etc., with sulphide of sodium. Sulpho blacks of this kind are known in the trade as "immedial black," "katigen black," "cross dye black" and "St. Denis black." Arsenic in this class of dyes is probably derived from the sulphide.

Two cases of arsenical poisoning from the wearing of dress goods have come directly to the notice of the Board. In one case, some time prior to the passage of the new law, a print wrapper, known to have caused quite a serious illness, was found on analysis made in this department to be highly arsenical.

The second instance occurred since the law went into effect. A red plaid gingham, purchased in a Boston store, was made into a dress for a child four years old. Apparent symptoms of poisoning were noticed the first day the dress was worn, and an examination of the goods made by the writer showed 1.024 grains of metallic arsenic per square yard. Samples of similar goods from the same store were at once purchased, and one was found containing 1.206 grains per square yard.

Methods of Analysis. — A standard arsenic mirror is made with considerable care, containing .001 of a grain of arsenic. This amount it is found can be readily weighed on an assay balance used especially for this work, and sensitive to .01 of a milligramme. The amount of arsenic in the standard mirror, namely, .001 of a

grain, is the legal limit for a piece of dress goods measuring .1 of a square yard, or for a piece of wall paper, or woven fabric other than dress goods, measuring .01 of a square yard. Patterns for the two classes of the goods are accordingly used for the test, measuring respectively .1 and .01 of a square yard. The pattern commonly used for dress goods measured 12 inches by 10.8 inches, and for wall papers 4 inches by 3¼ inches.

A piece of the sample cut out the exact size for the test is cut into small bits, placed in a casserole and moistened with a few drops of concentrated nitric acid and rather more concentrated sulphuric acid, and gently heated with constant stirring over the Bunsen flame till the sample is reduced to a dry black char, which is finely pulverized in the original casserole by means of a pestle. The dish is then cooled, distilled water is added, and the solution is brought to the boiling point while stirring over the gas flame, and again allowed to cool. When a large number of samples are to be examined, four sets of Marsh apparatus are usually run simultaneously, each being provided with an entrance tube having a 60° funnel at the top, instead of the ordinary thistle tube usually employed, so that the filter paper can be folded directly into the top of the funnel tube. The Marsh apparatus is run in the usual manner, using chemically pure zinc and sulphuric acid, and providing a chloride of calcium drying tube between the generator and the hard glass capillary tube. After running the apparatus in each case long enough to prove the absence of arsenic in the reagents, the aqueous solution with the char is poured into the moistened filter in the top of the funnel tube and allowed to filter directly into the generator. The length of time necessary to deposit all the arsenic in the sample, or to prove the absence of arsenic, varies with the conditions; but in general, if no darkening of the tube occurs after half an hour's time, the sample may be considered free from arsenic. At the end of the test the tube is compared with that containing the standard mirror, and it is at once generally apparent to the eye whether or not the amount exceeds the standard. If less than the standard mirror, it is reported as arsenical below the legal limit; if about the same or more than the standard mirror, the capillary containing the mirror is cut off from the bulk of the tube, and weighed, after drying, on the assay balance. The capillary is then immersed in a solution of hypochlorite of sodium,

which, if arsenic is present, at once dissolves it out from the tube, showing that the mirror is made up of arsenic and not antimony, which of course would not dissolve. The capillary is then washed, first with water by means of the wash bottle, then with a few drops of alcohol, and is finally dried above the flame. It is then cooled and again weighed in the assay balance, the difference in weight corresponding to the metallic arsenic.

A few samples were found to contain both arsenic and antimony, but with the arsenic largely in excess. By the above method of procedure experiment has shown that with mixtures of arsenic and antimony a small amount of antimony when present tends to hold back the arsenic in the capillary tube, when treated with the sodium hypochlorite, so that the arsenic results obtained thus by difference are somewhat low. Repeated trials of the method where arsenic alone is present have shown that it gives most satisfactory results.

Chromium in Black Stockings. — Several cases of poisoning undoubtedly due to the wearing of black stockings containing chromium have come to the notice of the Board, and resulted in the examination of the amount of chromium salts present in black stockings as found upon the market. In spite of the fact that chrome poisoning has been known for years, it is very rare indeed that black stockings are found in which chromium does not exist in more or less quantity. In fact, chrome is almost universally used in dyeing the sulpho blacks which were mentioned under the head of arsenic. But it is generally assumed that the chromium exists in the dyed fabric in the form of a hydrated sesquioxide, so firmly held as a part of the dye as to be inseparable therefrom, and hence, so the manufacturers claim, should be harmless, being insoluble. In spite of this, cases of occasional poisoning are traced directly to the wearing of black stockings. This may be due to the fact that in some instances bichromate of potash or soda is used in such large excess as not all to be converted into the insoluble hydrate, but to be still in the form of bichromate, and hence soluble, not being washed out for fear of injuring the dye, as each washing on such blacks as the sulpho dyes causes the black to be less glossy or deep, and hence detracts from its appearance.

Repeated experiments have, however, been tried in this laboratory on samples of stockings high in chromium with a view to removing the soluble bichromate by long-continued boiling, but in no case

has the hot water extract shown any trace of chromium. It is probable that the perspiration acts as a solvent on the supposed insoluble chromium salts, and that some people are much more susceptible than others to the effect of these salts. It is possible that more or less slight abrasion of the skin may be a necessary condition to this form of poisoning.

Out of the 36 samples of stockings examined for chromium, only 2 were found to be entirely free therefrom. The results of the examination are summarized as follows: —

Chromium in Stockings.

	Total Number examined.	Number containing Chromium.	Number free from Chromium.
Black cotton,	32	31	1
Black woollen,	1	1	–
Brown cotton,	1	–	1
Blue cotton,	1	1	–
Blue worsted,	1	1	–
	36	34	2

	Per Cent. Cr_2O_3.
8 samples contained	.27 to .91
8 samples contained	1.04 to 1.47
11 samples contained	1.54 to 1.98
4 samples contained	2.05 to 3.97

Four samples of stockings were examined that had been worn by employees of the Board with no apparent ill effects, showing .91 per cent., 1.65 per cent., 1.83 per cent. and 2.11 per cent. respectively of Cr_2O_3.

Method for Determining Chromium. — Two grammes of the cloth sample is burnt to an ash in a platinum crucible, and the ash is fused with sodium carbonate. The fusion is dissolved in water, and the solution is filtered. If the residue is green, it should be burned and fused again, and the aqueous solution of the second fusion added to the first. The solution is made acid, ammonia is then added, and the aluminum hydrate, if present, separated by filtration. The filtrate is made acid, sodium sulphite or sulphurous acid is added to reduce the chromate, and an excess of ammonia added. The solution is filtered off, and the precipitate washed, ignited and weighed as Cr_2O_3.

REPORT

UPON THE

Production, Distribution and Use of Diphtheria Antitoxin.

REPORT

UPON THE

Production, Distribution and Use of Diphtheria Antitoxin,

FOR THE

Year ended March 31, 1901.

The following report contains the essential data relative to the production and distribution of diphtheria antitoxin under the supervision of the State Board of Health during the year ended March 31, 1901. A summary is also presented of the work of previous years since the Board first began the work of producing antitoxin in 1894.

As a condition of the use of antitoxin by boards of health, physicians, hospitals and others, it was required that a return should be made in each case where antitoxin was used upon blank forms furnished by the Board, upon which the details of each case were to be recorded. A portion only of these returns have been made, and hence the report must be deemed to be incomplete so far as the use of antitoxin is concerned.

The returns contributed from the Boston City Hospital form a large share of the report, since these are more complete than those received from other parts of the State.

The supervision of antitoxin production has been carried on, as in former years, under the charge of Dr. Theobald Smith, at the Bussey Institute, near the Forest Hills station of the New York, New Haven & Hartford Railroad in Roxbury. The distribution has been conducted at the State House, from the office of the Board.

The strength of the serum employed has varied from 200 to 400 units per cubic centimeter, and the serum has usually been issued in

a 5 cubic centimeter vial, containing 1,500 units. For convenience, a vial containing 20 cubic centimeters has also been employed for use where several patients are to be treated at once, or where unusually large doses are used. The serum has been distributed throughout the whole State, wherever it has been called for, to local boards of health, to infectious disease hospitals and to physicians in private practice, the latter being usually supplied through the local boards of health. In many instances the local board of health has placed it in charge of a druggist, where it could be obtained at any time during the day or night.

It is doubtful if any remedy used for the treatment or prevention of disease, in the whole range of therapeutics, has become so strongly intrenched in the confidence of the medical profession, as diphtheria antitoxin. Scarcely any one could now be found who would be willing to undertake the treatment of diphtheria without this valuable aid. Expressions of doubt as to its usefulness are now rarely heard.

The total number of packages issued by the Board during the six years ending with March 31, 1901, was as follows: —

In 1895–1896 (year ending March 31),	1,724 bottles.
In 1896–1897 (year ending March 31),	3,219 bottles.
In 1897–1898 (year ending March 31),	4,668 bottles.
In 1898–1899 (year ending March 31),	12,491 bottles.
In 1899–1900 (year ending March 31),	31,997 bottles.*
In 1900–1901 (year ending March 31),	53,389 bottles.
Total,	107,488 bottles.

In consequence of the variable strength of the product, it would be difficult to present an exact numerical statement, in units, of the antitoxin issued in these packages, the tendency having been to increase its strength from year to year. The total amount thus far issued is probably about 140,000,000 units.

An account was kept during the year of the amount of antitoxin employed in each case, with few exceptions, the result of which is shown in the following table: —

* These numbers have reference to the actual number of bottles issued in packages of about 1,500 units each. In order to make this comparable with the figures of the first three years (1895-98), a package of 1,000 units should be employed as a standard, so that the 85,386 bottles distributed during the last two years would be equivalent to nearly 125,000 of the strength at first employed.

Amount of Antitoxin Used.	Number of Cases.	Deaths.	Amount of Antitoxin Used.	Number of Cases.	Deaths.
Less than 1,000 units, . .	60	2	5,000 to 10,000 units, . .	855	80
1,000 to 1,500 units, . .	570	26	10,000 to 15,000 units, . .	377	49
1,500 to 2,000 units, . .	235	4	15,000 to 20,000 units, . .	354	49
2,000 to 3,000 units, . .	559	38	20,000 and more units, .	518	126
3,000 to 4,000 units, . .	752	36	Unknown, ...	23	5
4,000 to 5,000 units, . .	205	19			

There were 3,236 cases in which the amount of antitoxin administered did not exceed 10,000 units in each case, and there were 1,249 cases in which the dose exceeded 10,000 units, and of these latter there were 518 in which the dose exceeded 20,000 units in each case.

The unusual demand for diphtheria antitoxin in the year 1900 is accounted for by the fact that the number of reported cases in the State largely exceeded that of any previous year since the system of notification of infectious diseases was generally adopted by cities and towns.

Further comment has also been made in the reports of previous years upon the comparatively small ratio of reports which have been made relative to the use of the product by physicians. The same comment may also be made with reference to the work of the past year. The reports have exceeded in number those of 1899, but the ratio to the number of cases remains about the same.

The figures presented in this report speak for themselves so far as the reduction which has taken place in the fatality of diphtheria is concerned. The fatality in the pre-antitoxin period, as shown in past reports of this Board, was 28.3 per cent. for the period of four years, 1891–94, while during the years 1895–1900 the general fatality from diphtheria throughout the State was only 10.2 per cent.

The strength of antitoxin distributed by the Board averaged about 425 units per cubic centimeter.

The whole number of cities and towns to which antitoxin was distributed was 144, or 30 more than those which were published in the report of 1899. The actual number in each year was probably somewhat larger than these figures, since a few of the more distant

cities acted as distributing centres for small towns in their neighborhood, and in some instances no returns were made from these towns. This serum was distributed to local boards of health and to physicians in the following cities and towns: —

Number of Bottles of Diphtheria Antitoxin distributed from April 1, 1900, to March 31, 1901.

City or Town.	Number Bottles.	City or Town.	Number Bottles.
Boston:		Woburn,	270
City Hospital,	26,735	Fitchburg,	251
Children's Hospital,	300	Malden,	234
Massachusetts General Hospital,	209	Brockton,	212
Parental School,	146	Arlington,	150
St. Mary's Hospital,	125	Revere,	140
Massachusetts Charitable Eye and Ear Infirmary.	113	Pittsfield,	124
West End Nursery,	42	Medford,	115
Little Wanderers' Home,	25	New Bedford,	114
Hull Street Medical Mission,	24	Watertown,	114
Massachusetts Homœopathic Hospital,	14	Leominster,	103
Gwynne Home for Children,	10	Gloucester,	102
Deer Island Hospital,	2	Weymouth,	100
General Supply,	5,148	Clinton,	96
Cambridge,	2,963	Danvers,	96
Worcester,	2,016	Fall River,	96
Waltham,	1,548	Marlborough,	91
Massachusetts School for the Feeble-minded.	11	Randolph,	86
Somerville,	1,504	Hyde Park,	84
Brookline,	1,198	Melrose,	84
Newton,	1,094	Reading,	84
Lynn,	941	Taunton,	84
Lawrence,	715	Haverhill,	78
Salem,	684	Palmer,	78
Quincy,	440	Marblehead,	76
Chelsea,	425	Attleborough,	72
Lowell,	410	Peabody,	70
Everett,	359	Winchester,	65
Holyoke,	326	Lexington,	58
Wakefield,	321	Northampton,	58
Springfield,	304	Concord,	50
Milford,	288	Framingham,	48

Number of Bottles of Diphtheria Antitoxin distributed from April 1, 1900, to March 31, 1901 — Continued.

City or Town.	Number Bottles.	City or Town.	Number Bottles.
West Springfield,	48	Needham,	15
Winthrop,	48	Braintree,	15
Stoneham,	45	Wayland,	15
Amesbury,	42	West Brookfield,	14
Chicopee,	42	Whitman,	13
Milton,	42	Bedford,	12
Maynard,	39	Brookfield,	12
Natick,	37	Conway,	12
North Adams,	36	Foxborough,	12
North Brookfield,	36	Greenfield,	12
Monson,	35	Hudson,	12
Norwood,	33	Millbury,	12
Acton,	30	Newburyport,	12
Adams,	30	Norwell,	12
Beverly,	30	South Hadley,	12
Medfield,	30	Southampton,	12
Middleborough,	28	Stoughton,	12
Dedham,	27	Wilbraham,	12
North Andover,	27	Westborough,	11
Hingham,	24	Ayer,	9
Rockland,	24	Hyannis,	9
Tewksbury,	24	Orleans,	8
State Hospital,	12	Blandford,	7
Cohasset,	21	Braintree,	7
Ludlow,	21	Swampscott,	7
Wellesley,	20	Abington,	6
Saugus,	19	Ashburnham,	6
Andover,	18	Ashland,	6
Bellingham,	18	Bridgewater,	6
Belmont,	18	Dighton,	6
Gardner,	18	Douglas,	6
Lincoln,	18	Falmouth,	6
Plymouth,	18	Hardwick,	6
Warren,	18	Hopedale,	6
North Attleborough,	16	Lancaster,	6
Southborough,	16	State Industrial School,	18

Number of Bottles of Diphtheria Antitoxin distributed from April 1, 1900, to March 31, 1901 — Concluded.

City or Town.	Number Bottles.	City or Town.	Number Bottles.
Nantucket,	6	Cottage City,	3
Scituate,	6	Edgartown,	3
Shirley,	6	Topsfield,	3
Sterling,	6	Marion,	3
Westford,	6	Marshfield,	3
Winchendon,	6	Sharon,	3
Wareham,	5	Royalston,	3
Colrain,	4	Spencer,	3
Harvard,	4	Georgetown,	2
Rowley,	4	West Newbury,	2
Templeton,	4	Wilmington,	1
Ware,	4	Total,	53,389
Yarmouth,	4		

From the foregoing table it appears that the distribution of antitoxin bore no relation to the number of the population which was supplied. Its relation, however, to the number of reported cases of diphtheria occurring in different districts was quite apparent.

The amount of antitoxin supplied to Boston with a population amounting to 20 per cent. of that of the State, was 61 per cent. of the whole amount distributed, and 50 per cent. was furnished to the isolation hospital.

The metropolitan district, including all cities and towns within ten miles of Boston, and having 40 per cent. of the entire population of the State, used 84 per cent. of the product of the year.

The reported cases of diphtheria in Boston in 1900 were very nearly 40 per cent. of the total number reported from the whole State, and those of the metropolitan district were 72 per cent. of the whole.

Summary Observations upon the Use of Diphtheria Antitoxin in Massachusetts during the Year ended March 31, 1901.

Cases in which a Bacterial Examination was made.

The same methods of classification are continued in this report as were adopted in the reports of the previous five years. The cases in which cultures were made are classified into positive and negative cases. Diagnostic examinations were made in 3,866 cases reported to the Board as having been treated with antitoxin, and of these, 3,472 proved to be genuine cases of diphtheria and 394 gave a negative result.

Positive Cases.

Of the 3,472 positive cases, or those in which a diagnosis of diphtheria was made by bacterial cultures from the throat of the patient, there were 3,145 recoveries and 327 deaths, or 9.4 per cent., the results of the previous years having been, respectively, 13.7, 11.6, 8.2, 7.9 and 11.4 per cent.

Sex. — The number of males was 1,675, and the deaths of these were 186, or 11.1 per cent. The females were 1,765, and the deaths of these were 138, or 7.8 per cent. The sex of 32 was not stated; of these there were 3 deaths.

Ages. — The following table shows the cases and deaths by ages: —

Year ended March 31, 1901.

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.). 1900.	Fatality (Per Cent.). 1899.
From 0 to 2 years,	374	81	21.7	26.1
From 2 to 5 years,	1,111	138	12.4	12.9
From 5 to 10 years,	1,058	56	5.3	8.5
Over 10 years,	800	37	4.6	2.5
Age unknown,	129	15	11.7	18.6
	3,472	327	9.4	11.4

Day of Illness when Antitoxin was first administered. — The following table presents the fatality, according to the day of illness on which the antitoxin was first administered: —

Day.	Cases.	Deaths.	Fatality (Per Cent.).					
			1900.	1899.	1898.	1897.	1896.	1895.
First, . . .	295	19	6.4	9.8	8.2	8.0	0.0	0.0
Second, . .	850	51	6.0	5.6	1.8	8.9	9.5	9.7
Third, . .	774	60	7.7	12.8	6.2	7.0	8.3	8.7
Fourth, . .	493	56	11.3	14.1	13.2	3.0	22.7	15.4
Fifth, . .	256	38	14.8	15.6	11.8	11.8	0.0	22.2
Sixth, . .	128	27	21.1	17.9	20.0	0.0	14.3	20.0
Seventh, . .	80	11	13.7	27.1	9.5	30.0	25.0	33.3*
Eighth and later,	154	26	16.8	14.7	10.4	13.6	16.6	–
Unknown, . .	442	39	–	–	–	–	–	–
	3,472	327	–	–	–	–	–	–

* Seventh day and later.

The value of the foregoing table consists mainly in the definite statement of the fatality of cases according to the day of illness at which antitoxin treatment was begun. In general, it shows that the ratio of success in treatment depends largely upon the early date at which antitoxin is first administered. A fuller and more conclusive summary containing greater numbers may be found on a later page.

The cases in which antitoxin treatment was begun either upon the first, second or third days of illness constituted 55.3 per cent. of the whole number of positive cases to which antitoxin was administered during the year under consideration.

Hospitals and Private Practice.

	Cases.	Deaths.	Fatality (Per Cent.).
In hospitals, ...	2,620	279	10.6*
In private practice, ...	852	48	5.6*

* This apparent difference in the fatality of hospital and of general or outside treatment with antitoxin is accounted for by the fact that a considerable number of severe and fatal cases of diphtheria, which were treated by physicians in general practice, were transferred to a hospital after one or more days of home treatment and died at the hospital.

Seasons of the Year. — The cases embraced in the foregoing enumeration occurred in the following order : —

Months.	Cases.	Deaths.	Months.	Cases.	Deaths.
1900.			**1900.**		
April,	235	27	October,	382	18
May,	231	30	November,	450	40
June,	222	19	December,	385	30
July,	167	20	**1901.**		
August,	244	24	January,	288	34
September,	350	27	February,	235	31
			March,	275	26
Total six months,	1,449	147	Total six months,	2,015	179

By the foregoing table it appears that there were 1,449 positive cases reported in the warmer months, with 147 deaths, and 2,015 cases in the colder months, with 179 deaths. In 8 cases and 1 death the date was not given.

Negative Cases.

The reported cases in which a negative result was obtained were 394 ; and the deaths of these were 41, or 10.4 per cent.

Sex. — The males were 182, with 18 deaths, or 9.9 per cent., and the females 211, with 22 deaths, or 10.4 per cent. ; and there was 1 case and 1 death in which the sex was not stated.

Age. — The percentage of fatality by ages was as follows : 0 to 2 years, 23.5 per cent. ; 2 to 5 years, 16.1 per cent. ; 5 to 10 years, 6.5 per cent. ; and all over 10 years, 2.6 per cent.

Summary of the Six Years ended March 31, 1901.

Positive Cases treated with Antitoxin.

Whole number of cases for the six years, 7,876 ; deaths, 779 ; fatality, 9.9 per cent.

Sex. — The fatality by sexes was as follows : —

Sex.	Cases.	Deaths.	Fatality (Per Cent.).
Males,	3,722	398	10.7
Females,	4,070	366	9.0

The sex of 84 was not stated ; 15 deaths.

Ages. — The fatality by ages was as follows: —

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.).
0 to 2 years,	906	201	22.2
2 to 5 years,	2,642	329	12.4
5 to 10 years,	2,326	154	6.6
Over 10 years,	1,797	68	3.8
Age unknown,	205	27	–

Hospitals and Private Practice.

	Cases.	Deaths.	Fatality (Per Cent.).
In hospitals,	5,716	621	10.9
In private practice,	2,160	158	7.3

Cases in which no Bacteriological Examination was made during the Year ended March 31, 1901.

Reports were received of 641 cases where antitoxin was employed in which no cultures were taken. Of this number, 379, or nearly 60 per cent., occurred in general practice and the remainder were reported from hospitals. Of the whole number, 67 proved fatal, or 10.5 per cent.

Sex. — The number of males in this class was 295, and the deaths of these were 28, or 9.5 per cent. The number of females was 334, and the deaths of these were 38, or 11.3 per cent. The number of those whose sex was unknown or not stated was 12, of which number one died.

Ages. — The following table presents the cases and fatality by ages among this class: —

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.).
From 0 to 2 years,	80	16	20.0
From 2 to 5 years,	217	23	10.6
From 5 to 10 years,	184	16	8.7
Over 10 years,	148	11	7.4
Age unknown,	12	1	–

Sequelæ.

Temporary skin eruptions, usually of brief duration, are of very common occurrence after the administration of antitoxin. Frequently these eruptions are quite mild and confined to a small area adjoining the place of injection, while occasional instances occur in which the eruption spreads throughout the entire surface of the body, or at least a large portion of its area.

During the year under consideration, such eruptions or rashes are reported as occurring in 1,366 instances in which antitoxin was administered. Of this number, 85 per cent. were mild in character and the remainder were severe or extensive.

Albuminuria was reported in 454 instances, of which 86 per cent. were slight, or consisted of a trace only. The presence of albuminuria, however, has no significance as relating to the administration of antitoxin, since albuminuria is present according to good authorities in the majority of severe cases of diphtheria.*

Operations.

Tracheotomy, an operation which was once quite commonly resorted to in severe cases of laryngeal diphtheria, appears to have been almost entirely supplanted by the more safe and simple operation of intubation.

Tracheotomy is reported as having been performed 7 times during the year, with 4 deaths.

Intubation is reported as having been performed 212 times during the year, with 65 deaths, or 30.7 per cent., which was almost exactly the same as that of the previous year (30.8 per cent.).

The complications of diphtheria which were met with among the patients treated with antitoxin were much the same as those of the preceding year, and consisted mainly of instances in which scarlet-fever or measles occurred simultaneously with diphtheria. Other infectious diseases also occasionally appeared as complications, but so far as can be learned these complications were no more common than they were before the introduction of antitoxin as a therapeutic or preventive remedy. Pneumonia was of rarer occurrence as a complication than scarlet-fever or measles, but when present, the cases proved fatal in the majority of instances.

* Osler's "Practice of Medicine," 2d edition, p. 115.

By far the most important lesson to be learned from the returns which have been received since the introduction of antitoxin treatment is the necessity of *early administration of antitoxin in each and every case.*

Immunization.

Returns of cases in which antitoxin was used for the purpose of immunizing persons who had been exposed to the infection of diphtheria were received in only 86 cases, although quantities of antitoxin were issued for this purpose which would indicate a much larger number of persons thus treated. Out of this number, 51 were inmates of the insane hospital at Northampton who had been exposed to an outbreak of diphtheria. The use of antitoxin in these cases appears to have been entirely successful for the purposes for which it was used. In 10 of the cases thus treated diphtheria bacilli were found in the throat, but clinical symptoms of the disease were entirely absent in all of them.

General Summary, 1895–1900.

Positive cases treated in the years ending March 31, 1901, and reported to the State Board of Health,	7,876
Cases in which no bacteriological examination was made,	2,125
Total,	10,001*
Deaths of these,	1,051
Fatality (per cent.),	10.5

Sexes.

The number of males who were treated was †	4,688
The number of females who were treated was †	5,159
The number whose sex was not stated was †	154
Total,	10,001*
Deaths of males,	531
Fatality of males (per cent.),	11.3
Deaths of females,	496
Fatality of females (per cent.),	9.6
Deaths, sex not stated,	24

* In this number (10,001) 1,035 cases in which a bacterial diagnosis showed negative results are not included, so that the whole number treated with antitoxin of which returns were made to the Board was 11,036.

† Except cases determined to be "negative."

Deaths by Ages.

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.).
0 to 2 years,	1,164	267	22.9
2 to 5 years,	3,315	434	13.1
5 to 10 years,	2,982	222	7.4
Over 10 years,	2,288	96	4.2
Age unknown or not stated,	252	32	12.7
Total,	10,001	1,051	10.5

The following table contains the results of those cases only which had been determined by a culture examination to be positive, with reference to the fatality of the disease in each group of cases, considered in relation to the stage of the disease when antitoxin was first administered.

Nothing can be more conclusive than the cumulative testimony of these figures, supported as they are by similar experience elsewhere, as to the importance of the earliest possible administration of antitoxin in the treatment of diphtheria. Each day's delay renders the liability to a fatal result greater.

The fatality of the cases which were treated with antitoxin very early in the course of the disease (that is, before the termination of forty-eight hours from its onset) was only 6.4* per cent., or 208 deaths in 3,265 cases, while that of the cases which were not thus treated until the sixth day or later was as high as 17.8 per cent., or nearly three times as great.

Day of Administration.

Day.	Cases.	Deaths.	Fatality (Per Cent.).
First,	1,026	75	7.3
Second,	2,239	133	5.9
Third,	1,770	170	9.6
Fourth,	1,201	157	13.1
Fifth,	637	97	15.2
Sixth and later,	886	158	17.8

And there were 1,309 cases in which the day on which antitoxin was first administered was not stated, and of these there were 153 deaths.

* The sum of the experience of the first two days is expressed in this figure.

Diphtheria Cultures examined during the Year ended March 31, 1901.

During the year ended March 31, 1901, 5,173 cultures have been received from 144 towns and cities in the State. Of these, 2,047 were made for the purpose of diagnosis and 3,126 for release from quarantine. The following table gives the number of cultures received from the different towns and cities and the results of the examinations: —

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.			Cultures examined for Release from Quarantine.
		Positive.	Negative.	Doubtful.	
Acton,	3	–	3	–	–
Adams,	3	–	–	–	3
Amesbury,	1	–	1	–	–
Andover,	28	7	19	–	2
Arlington,	229	26	21	–	182
Ashland,	1	1	–	–	–
Attleborough,	20	8	11	1	–
Avon,	1	1	–	–	–
Barnstable,	1	1	–	–	–
Bedford,	2	1	1	–	–
Belchertown,	1	1	–	–	–
Belmont,	22	4	1	–	17
Berlin,	1	–	1	–	–
Beverly,	41	10	9	–	22
Bolton,	1	–	1	–	–
Boston,	5	3	2	–	–
Boxford,	1	–	–	–	1
Braintree,	7	4	3	–	–
Bridgewater,	87	5	9	–	73
Brockton,	5	1	–	–	4
Brookfield,	1	–	1	–	–
Cambridge,	9	–	7	–	2
Carver,	2	2	–	–	–
Chelsea,	293	63	30	2	198
Clinton,	104	15	20	–	69
Cohasset,	21	2	2	–	17
Colrain,	4	4	–	–	–
Concord,	14	5	9	–	–

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.			Cultures examined for Release from Quarantine.
		Positive.	Negative.	Doubtful.	
Danvers,	163	31	48	–	84
Dartmouth,	1	–	1	–	–
Dedham,	2	1	–	–	1
Dover,	4	–	–	–	4
Duxbury,	14	3	1	–	10
Everett,	463	60	69	–	334
Fall River,	1	–	1	–	–
Fairhaven,	3	–	–	–	3
Falmouth,	6	1	2	–	3
Foxborough,	18	5	7	–	6
Framingham,	52	13	9	–	30
Gloucester,	45	19	16	–	10
Great Barrington,	4	4	–	–	–
Greenfield,	40	3	13	–	24
Haverhill,	40	13	18	–	9
Hingham,	35	4	9	1	21
Holbrook,	1	–	1	–	–
Hopedale,	3	1	2	–	–
Hyde Park,	47	7	9	–	31
Lancaster,	3	1	1	–	1
Lawrence,	44	14	19	1	10
Leominster,	9	3	5	–	1
Lexington,	19	3	12	1	3
Lincoln,	75	1	4	–	70
Lynnfield,	1	1	–	–	–
Malden,	338	31	49	2	256
Marblehead,	122	27	40	–	55
Marlborough,	63	14	15	–	34
Marion,	9	1	2	–	6
Marshfield,	11	1	–	–	10
Medfield,	28	4	6	–	18
Medford,	131	28	62	–	41
Melrose,	124	16	37	–	71
Methuen,	2	2	–	–	–
Middleborough,	19	5	5	–	9
Milford,	1	1	–	–	–
Milton,	111	16	29	1	65
Nantucket,	1	–	–	1	–
Natick,	6	3	3	–	–
Needham,	5	1	4	–	–
New Bedford,	83	8	17	1	57
Newbury,	1	1	–	–	–
Newburyport,	36	2	21	–	13
Newton,	6	1	4	–	1
Norfolk,	1	–	1	–	–
North Adams,	20	6	10	–	4
North Attleborough,	12	7	2	–	3
North Brookfield,	6	1	3	–	2
Norwell,	10	4	1	–	5
Norwood,	21	4	4	–	13
Orleans,	10	–	1	–	9
Oxford,	4	1	–	–	3

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis. Positive.	Negative.	Doubtful.	Cultures examined for Release from Quarantine.
Palmer,	5	2	–	–	3
Peabody,	31	4	4	–	23
Pittsfield,	11	5	4	–	2
Plymouth,	7	–	–	–	7
Quincy,	123	32	46	–	45
Randolph,	7	6	1	–	–
Reading,	109	12	23	–	74
Revere,	27	9	5	–	13
Rockland,	8	–	8	–	–
Salem,	549	48	36	1	464
Saugus,	28	6	3	–	19
Scituate,	2	–	2	–	–
Sherborn,	2	2	–	–	–
Shirley,	1	1	–	–	–
Somerville,	322	91	122	2	107
Southborough,	1	–	1	–	–
Southbridge,	4	1	2	–	1
Sterling,	4	1	2	–	1
Stockbridge,	1	1	–	–	–
Stoneham,	13	6	6	–	1
Swampscott,	17	2	6	–	9
Taunton,	5	1	3	–	1
Templeton,	1	1	–	–	–
Topsfield,	2	–	2	–	–
Wakefield,	64	9	15	–	40
Ware,	1	1	–	–	–
Wareham,	1	–	1	–	–
Warren,	36	5	5	–	26
Watertown,	199	13	24	1	161
Wellesley,	42	4	3	–	35
Westborough,	8	2	3	–	3
West Boylston,	6	2	1	–	3
Westford,	1	–	1	–	–
Weymouth,	4	2	1	–	1
Wilmington,	5	4	1	–	–
Winchendon,	18	3	5	–	10
Winchester,	130	25	35	–	70
Winthrop,	118	14	33	–	71
Woburn,	64	22	32	–	10
Yarmouth,	3	3	–	–	–
Unclassified,	2	–	2	–	–
State,	5,173	878	1,154	15	3,126

Persistence of Diphtheria Bacilli in the Throats of Patients Convalescent from Diphtheria.

Among these cases are included only those in which frequent cultures were made until the throat was clear of the bacilli. The

time of persistence is given from the date of the earliest symptoms to when the bacilli were last found in cultures from the throat.

Time of Persistence.	Number of Cases.	Time of Persistence.	Number of Cases.
7 days, ...	3	40 days, ...	3
8 days, ...	3	41 days, ...	3
9 days, ...	7	42 days, ...	5
10 days, ...	4	43 days, ...	3
11 days, ...	3	45 days, ...	1
12 days, ...	10	46 days, ...	3
13 days, ...	9	47 days, ...	3
14 days, ...	14	48 days, ...	3
15 days, ...	18	49 days, ...	4
16 days, ...	21	50 days, ...	1
17 days, ...	11	51 days, ...	1
18 days, ...	20	52 days, ...	2
19 days, ...	15	53 days, ...	1
20 days, ...	16	54 days, ...	1
21 days, ...	25	55 days, ...	2
22 days, ...	31	56 days, ...	2
23 days, ...	13	57 days, ...	1
24 days, ...	16	60 days, ...	1
25 days, ...	20	63 days, ...	1
26 days, ...	10	65 days, ...	2
27 days, ...	12	67 days, ...	1
28 days, ...	13	70 days, ...	1
29 days, ...	13	72 days, ...	1
30 days, ...	8	77 days, ...	1
31 days, ...	5	90 days, ...	1
32 days, ...	9	93 days, ...	1
33 days, ...	3	99 days, ...	1
34 days, ...	10	106 days, ...	1
35 days, ...	9	107 days, ...	1
36 days, ...	13	185 days, ...	1
37 days, ...	4		
38 days, ...	5	Average, 27 days, .	429
39 days, ...	3		

Relation of Clinical to Bacteriological Diagnosis.

Clinical Diagnosis.	Bacteriological Diagnosis.		
	Positive.	Negative.	Doubtful.
Positive in 722 cases, ...	482	235	5
Negative in 399 cases, ...	77	318	4
Doubtful in 608 cases, ...	218	385	5
Not given in 318 cases, ...	101	216	1

Summary of the Five Years ended March 31, 1901.

The whole number of cultures examined during the five years is as follows: —

In 1896–1897 (year ended March 31),	1,469
In 1897–1898 (year ended March 31),	2,204
In 1898–1899 (year ended March 31),	1,591
In 1899–1900 (year ended March 31),	3,258
In 1900–1901 (year ended March 31),	5,173
Total,	13,695

Of these 13,695 cultures, 6,668 were made for the purpose of diagnosis and 7,027 for release from quarantine. Of the cultures made for diagnosis, 2,859 were positive, 3,717 were negative and 92 were doubtful.

In the 6,668 cases examined for diagnosis the relation of clinical to bacteriological diagnosis was as follows: —

Clinical Diagnosis.	Bacteriological Diagnosis.		
	Positive.	Negative.	Doubtful.
Positive in 2,461 cases,	1,580	859	22
Negative in 1,346 cases,	267	1,058	21
Doubtful in 1,631 cases,	557	1,053	21
Not given in 1,230 cases,	458	747	25

In 1,120 cases, in which frequent cultures were made until the throat was free from the bacilli of diphtheria, the average time of persistence of the bacilli from the date of the earliest symptoms was 27.2 days.

EXAMINATION OF SPUTUM AND OTHER MATERIALS SUSPECTED OF CONTAINING THE BACILLI OF TUBERCULOSIS.

During the year ended March 31, 1901, microscopic examination has been made of 746 specimens of sputum and other material suspected of containing the bacilli of tuberculosis. This material was received from 86 different towns and cities in the State. The following table gives the places from which the material was received and the results of the examinations: —

City or Town.	Number of Cases examined.	Males.			Females.			Sex not stated.		
		Positive.	Negative.	Doubtful.	Positive.	Negative.	Doubtful.	Positive.	Negative.	Doubtful.
Abington,	1	–	–	–	–	1	–	–	–	–
Acton,	4	1	1	–	2	–	–	–	–	–
Adams,	5	1	2	–	1	1	–	–	–	–
Arlington,	15	–	1	–	3	7	–	2	2	–
Ashland,	1	–	–	–	–	–	–	1	–	–
Attleborough,	9	2	4	–	1	2	–	–	–	–
Barnstable,	2	–	1	–	1	–	–	–	–	–
Blackstone,	3	–	2	–	1	–	–	–	–	–
Boston,	75	21	20	–	11	16	–	3	3	1
Bridgewater,	6	3	–	–	2	–	–	–	1	–
Brockton,	19	4	3	–	4	7	–	1	–	–
Brookfield,	13	2	2	–	4	4	–	–	1	–
Brookline,	8	–	1	–	5	2	–	–	–	–
Cambridge,	1	–	1	–	–	–	–	–	–	–
Chelsea,	16	3	3	–	4	4	–	–	2	–
Cheshire,	1	–	–	–	1	–	–	–	–	–
Clinton,	6	–	1	–	1	3	–	1	–	–
Concord,	18	6	7	1	–	2	–	–	2	–
Cottage City,	2	1	–	–	–	–	–	1	–	–
Danvers,	8	4	–	–	2	2	–	–	–	–
Dedham,	6	1	2	–	–	1	2	–	–	–
Everett,	24	5	4	–	4	10	–	–	1	–
Fall River,	83	25	13	1	27	14	1	1	1	–
Foxborough,	12	1	1	–	5	4	1	–	–	–
Framingham,	12	3	1	–	3	4	–	1	–	–

City or Town.	Number of Cases examined.	Males.			Females.			Sex not stated.		
		Positive.	Negative.	Doubtful.	Positive.	Negative.	Doubtful.	Positive.	Negative.	Doubtful.
Franklin,	2	–	–	–	1	1	–	–	–	–
Georgetown,	4	–	–	–	–	4	–	–	–	–
Gloucester,	8	2	4	–	–	2	–	–	–	–
Greenfield,	5	–	3	–	1	1	–	–	–	–
Halifax,	1	–	–	–	1	–	–	–	–	–
Hanson,	1	–	1	–	–	–	–	–	–	–
Haverhill,	4	1	1	–	1	–	–	1	–	–
Hingham,	2	2	–	–	–	–	–	–	–	–
Hyde Park,	3	1	–	–	–	2	–	–	–	–
Lawrence,	33	7	7	–	6	8	2	1	2	–
Lexington,	8	–	2	–	3	3	–	–	–	–
Lincoln,	2	–	–	–	1	1	–	–	–	–
Littleton,	1	–	–	–	1	–	–	–	–	–
Lowell,	2	–	–	–	2	–	–	–	–	–
Malden,	10	–	3	–	3	4	–	–	–	–
Mansfield,	2	–	–	–	2	–	–	–	–	–
Marlborough,	7	3	1	–	–	–	–	2	1	–
Medford,	23	2	6	–	6	7	–	–	2	–
Melrose,	9	–	5	–	1	2	–	–	1	–
Methuen,	6	–	2	–	2	2	–	–	–	–
Milford,	1	–	1	–	–	–	–	–	–	–
Milton,	2	1	1	–	–	–	–	–	–	–
Natick,	2	1	–	–	–	–	–	–	1	–
Needham,	1	1	–	–	–	–	–	–	–	–
New Bedford,	15	4	6	–	2	3	–	–	–	–
North Adams,	30	6	7	–	8	7	–	–	2	–
North Attleborough,	9	4	1	–	4	–	–	–	–	–
North Brookfield,	4	2	2	–	–	–	–	–	–	–
Norwood,	2	1	1	–	–	–	–	–	–	–
Oxford,	4	–	1	–	1	2	–	–	–	–
Peabody,	1	–	–	–	1	–	–	–	–	–
Pembroke,	1	–	–	–	–	1	–	–	–	–
Pittsfield,	1	–	–	–	1	–	–	–	–	–
Quincy,	14	3	5	1	2	1	1	–	1	–
Randolph,	3	–	1	–	–	1	–	–	1	–
Reading,	12	1	5	–	2	4	–	–	–	–
Revere,	9	2	1	–	2	3	1	–	–	–
Rockland,	14	1	2	–	5	6	–	–	–	–
Salem,	6	–	2	–	1	2	–	1	–	–
Somerville,	18	4	5	–	3	6	–	–	–	–
Southbridge,	1	–	–	–	–	1	–	–	–	–
Spencer,	9	2	2	–	1	3	1	–	–	–
Swansea,	1	1	–	–	–	–	–	–	–	–
Taunton,	8	2	2	–	2	1	1	–	–	–
Topsfield,	1	–	–	–	–	1	–	–	–	–
Wakefield,	1	–	1	–	–	–	–	–	–	–
Waltham,	2	–	1	–	1	–	–	–	–	–
Warren,	9	1	2	–	4	2	–	–	–	–
Watertown,	4	–	2	–	–	2	–	–	–	–
Wenham,	1	–	–	–	–	–	–	1	–	–
Westborough,	1	–	1	–	–	–	–	–	–	–

City or Town.	Number of Cases examined.	Males.			Females.			Sex not stated.		
		Positive.	Negative.	Doubtful.	Positive.	Negative.	Doubtful.	Positive.	Negative.	Doubtful.
Westford,	9	–	1	1	1	2	4	–	–	–
Weymouth,	9	–	4	–	–	4	–	–	1	–
Whitman,	6	1	2	–	2	–	1	–	–	–
Winchendon,	5	–	2	–	–	1	–	1	1	–
Winchester,	16	–	4	1	1	8	–	–	2	–
Winthrop,	2	1	1	–	–	–	–	–	–	–
Woburn,	2	1	–	–	–	1	–	–	–	–
Worcester,	1	–	–	–	1	–	–	–	–	–
Worthington,	2	–	1	–	1	–	–	–	–	–
Not stated,	24	6	6	–	4	7	–	1	–	–
State,	746	147	178	5	163	190	15	19	28	1

Ages. — The relations of bacteriological diagnosis to age is shown in the following table: —

Age Periods.	Number of Cases examined.	Positive.	Negative.	Doubtful.
From 1 to 10 years,	12	3	9	–
From 10 to 20 years,	110	53	56	1
From 20 to 30 years,	234	132	94	8
From 30 to 40 years,	145	51	90	4
From 40 to 50 years,	84	33	48	3
From 50 to 60 years,	43	15	27	1
From 60 to 70 years,	20	6	14	–
From 70 to 80 years,	14	1	12	1
From 80 to 90 years,	1	–	1	–
Age not stated,	83	35	45	3
Total,	746	329	396	21

Sex. — The relations of bacteriological diagnosis to sex is shown in the following table: —

	Total.	Males.	Females.	Sex not stated.
Positive cases,	329	147	163	19
Negative cases,	396	178	190	28
Doubtful cases,	21	5	15	1
Total,	746	330	368	48

Clinical Diagnosis. — The relation of clinical diagnosis to bacteriological diagnosis is as follows: —

Clinical Diagnosis.	Bacteriological Diagnosis.		
	Positive.	Negative.	Doubtful.
Positive in 294 cases,	162	127	5
Negative in 95 cases,	20	70	5
Doubtful in 174 cases,	67	102	5
Not made in 183 cases,	80	97	6
Total, 746,	329	396	21

SUMMARY OF THE FIVE YEARS ENDED MARCH 31, 1901.

The whole number of specimens of sputum and other material examined for the bacilli of tuberculosis during the five years ended March 31, 1901, is 2,091. Of these, 939, or 44.9 per cent., contained the bacilli of tuberculosis, in 1,131 the bacilli were not found and in 21 the bacteriological diagnosis was doubtful.

Ages. — Of the 300 specimens from persons who were under twenty years of age, 41.7 per cent. were positive, of the 1,334 specimens from persons who were between the ages of twenty and fifty years, 47.4 per cent. were positive, and of the 223 specimens from persons who were over fifty years of age, 27.9 per cent. were positive. The age was not given in 234 cases. Of the *positive cases*, 123, or 13.1 per cent., were under twenty years of age, 636, or 67.7 per cent., were between twenty and fifty years of age, 62, or 6.6 per cent., were over fifty years of age, and in 118 the age was not given.

Sex. — Of the 2,091 cases from which material was examined, 965 were males, 999 were females and the sex was not stated in 127. Of the male cases 45.4 per cent. and of the female cases 45.3 per cent. were positive.

TYPHOID FEVER.

WIDAL, AGGLUTINATIVE OR SERUM TEST.

During the past three or four years physicians from various parts of the State have occasionally sent to the laboratory dried blood which they desired to have subjected to the Widal test. Up to the beginning of 1901 the laboratory had made no efforts to introduce this new method of diagnosis, partly because it was thought that the practising physician might place too much reliance upon a test so frequently negative in the first week of typhoid fever, — a time when it is most important to obtain reliable information concerning the nature of the disease under observation.

During the past year it became evident, however, that some simple uniform process for collecting and testing dried blood must be introduced in order to counteract the many diverse and unsatisfactory methods for sending it, improvised by physicians dependent on their own resources. Hence the following simple plan was devised, by selecting from among the many different procedures in use those features best adapted for the purpose.

A slip of thin, smooth paper, about four centimeters square, carefully weighed beforehand, and an aluminum wire loop are provided. The blood is transferred to the paper with the wire loop. On arrival at the laboratory the slip of paper with the dried drops of blood on it is weighed again. From these data the amount of fresh blood is calculated and a dilution of one volume of the latter to twenty of a young culture of typhoid bacilli is made, in which the agglutination is observed by microscopic examination from time to time. The instructions printed on the envelope containing the slip of paper and the wire loop are as follows: —

STATE BOARD OF HEALTH OF MASSACHUSETTS.

PATHOLOGICAL LABORATORY AT BUSSEY INSTITUTION, FOREST HILLS, BOSTON.

Method to be followed in collecting Blood for the Widal Test.

In applying this test the accuracy of the result obtained increases with the amount of blood available. Hence the following directions should be carefully followed: —

Cleanse thoroughly the part from which the blood is to be obtained (the end of finger, lobe of ear, etc.). Prick deeply with a sterilized (flamed) needle or scalpel, and transfer with enclosed loop three to five (or more) drops of blood upon the small slip of paper, each drop in a place by itself near the edge of the paper. Do not spread the blood, and wait until it is thoroughly dry before folding and replacing WITH THE WIRE LOOP in this envelope. Mail in a larger (return) envelope to the laboratory after filling out the blank enclosed.

The following blank is filled out by the physician requesting the diagnosis: —

[This blank must be filled out and mailed with the specimen of blood.]

Commonwealth of Massachusetts.

STATE BOARD OF HEALTH.

SERUM TEST IN SUSPECTED TYPHOID FEVER.

No.________________ Date of collection,________________________________

Patient's name,____

Address (town, etc.),____

Physician's name,____

Address (town, etc.),____

Date of beginning of disease,__________________________________

Any record of former typhoid or continued fever?__________________

____

Physician's diagnosis,____

Probable source of infection,__________________________________

____

In order that the result of the serum test may be properly estimated by the physician in charge, and that any danger arising from an erroneous diagnosis may be guarded against, the following explanatory statement accompanies the outfit: —

Commonwealth of Massachusetts.

STATE BOARD OF HEALTH.

DIAGNOSIS OF TYPHOID FEVER.

The serum test (Widal test) for typhoid fever is made by adding typhoid bacilli from a fresh culture to a certain dilution of blood or serum from suspected cases. The dilution chosen is usually 1 to 20, or somewhat higher.

When the typhoid bacilli become agglutinated or clumped into masses, and their motility partly or wholly checked, the reaction is considered positive.

A positive reaction indicates either that the patient yielding the blood is suffering with typhoid fever or has recently recovered from it, or has some localized affection in which typhoid bacilli are present.

A negative reaction is sometimes associated throughout with well-marked cases of typhoid fever, but such cases are rare. A negative reaction in most cases signifies either that the disease is not typhoid fever, or else that it is not yet sufficiently advanced to yield a positive reaction. This appears rarely later than the second week.

Inasmuch as the patient or convalescent may discharge typhoid bacilli in feces and urine and thereby endanger the health of individuals and communities, the Board urgently advises physicians who are in doubt of the clinical diagnosis to avail themselves of the facilities offered for increasing the certainty of the diagnosis by sending to the laboratory specimens of blood, if necessary, repeatedly, in order that proper precautions may be taken to locate sources of infection and to prevent the dissemination of typhoid bacilli.

The following table gives the results of the test as applied both before and after the distribution of the new outfits : —

Typhoid, April 1, 1900, to April 1, 1901.

City or Town.	Number of Cases.	Positive.	Negative.	City or Town.	Number of Cases.	Positive.	Negative.
Charlton, . .	1	1	–	Oxford, . .	2	–	2
Chelmsford, .	1	–	1	Reading, . .	2	1	1
Chelsea, . .	1	–	1	Revere, . .	2	–	2
Concord, . .	6	2	4	Saugus, . .	1	–	1
Danvers, . .	1	–	1	Somerville, .	7	–	7
Dedham, . .	1	1	–	Swampscott, .	1	1	–
Gloucester, .	1	–	1	Taunton, . .	2	1	1
Hyde Park, .	1	1	–	Waltham, . .	2	–	2
Marion, . .	1	–	1	Watertown, .	1	–	1
Marlborough, .	3	1	2	Wellesley, . .	2	1	1
Medway, . .	1	1	–	Westford, . .	4	1	3
Melrose, . .	1	–	1	Winthrop, . .	1	–	1
Needham, . .	11	5	6	Wrentham, .	1	–	1
North Adams, .	1	–	1				
North Easton, .	3	1	2	Total, . .	62	18	44

MALARIA.

The number of preparations of dried blood examined during the year for malaria parasites was 78, of which 15, or about 19 per cent., contained the parasites. These were, as heretofore, of the tertian variety. The number of negative cases is swelled by the fact that physicians occasionally send blood films from patients presumably free from malaria in order to get a report on the condition of the blood. This tendency is not to be encouraged, since the laboratory is not designed for purely clinical diagnosis. Moreover, the thorough examination of the blood cannot be made from dried preparations alone.

The following table gives the distribution of the positive and negative cases: —

Malaria.

City or Town.	Number of Cases.	Positive.	Negative.	City or Town.	Number of Cases.	Positive.	Negative.
Boston, . . .	1	-	1	Norwood, . . .	1	-	1
Clinton, . . .	4	2	2	Salem, . . .	1	-	1
Concord, . . .	21	7	14	Sterling, . . .	1	1	-
Foxborough, . .	4	-	4	Stow, . . .	3	-	3
Hyde Park, . .	2	-	2	Swampscott, . .	1	-	1
Lincoln, . . .	1	-	1	Uxbridge, . . .	6	1	5
Marlborough, . .	3	-	3	Waltham, . .	1	-	1
Medfield, . . .	1	-	1	Westford, . .	5	-	5
Melrose, . . .	3	-	3	Winchester, . .	13	3	10
Newton, . . .	6	1	5	Total, . . .	78	15	63

STATISTICS OF CANCER

IN

MASSACHUSETTS.

By W. F. WHITNEY, M.D.

STATISTICS OF CANCER IN MASSACHUSETTS.

Compiled by W. F. Whitney, M.D.

Much has been said of the alleged increase of cancer in Massachusetts, and a study of the statistics of the disease was made and the results given in the Shattuck lecture before the Massachusetts Medical Society in June, 1901. The main points may be briefly summarized as follows: —

1. If death from cancer should go on at the apparent rate of increase of the past fifty years, in two and a quarter centuries every person over thirty years would die from that disease.

2. This rate of increase is probably only arithmetical at its worst.

3. The assumed increase is probably due to better diagnosis and registration, and until the ratio of all of the deaths from cancer over thirty years to the total mortality of the same ages has reached 8 or 9 per cent., which is shown by autopsies to be the true rate for cancer, it is not justifiable to speak of the increase as inherent in the disease itself.

4. For purposes of comparison with other places or years, a "graphic picture," composed of both the death-rate and mortality percentage curves, covering the period over thirty years, divided into decades, is the best.

5. Comparison with other States and countries shows the rate for Massachusetts to be about the same as theirs, with greater variation between the males and females than is the case in Austria, which is remarkable for the correspondence between the two sexes.

6. In the distribution in the New England States there is no geographical feature that explains the slight variation, which is easily within the limits of better registration.

7. In the State itself there is a slight increase westward for groups of countries of the same density of population. The densest populated part of the State, apart from these, shows a little higher rate.

In the Shattuck lecture only the rates and mortality percentages were given, and it is proposed here to present the full tables from which they were computed. It is hoped that they may be of service if any one should wish to verify the figures and to facilitate the study of other diseases in the same way. For if the tables of the population and the total deaths had been available in a compact form, as here printed, many hours of work would have been spared.

The first table is the population of Massachusetts for both sexes and persons, for all ages over thirty years, and for each subsequent decade. These were taken from the census reports, except those for the decades of 1855, which had to be calculated, and are the arithmetical mean of those of the preceding and following census years.

The second table gives the average number of deaths from all causes for each of the census years. This was obtained by adding together the deaths for five years, including those of the census year as the centre, and dividing by five. In this way the objection to the use of a calculated population is done away with and the accident of any epidemic giving an abnormally large number of deaths for a single year is neutralized. It seems useless to give the number of deaths, year by year. For if it is desired to study a disease for any single year, the total deaths are to be found in the same volume of records; but in that case the population for the intercensus year will have to be calculated.

The third table gives the deaths from cancer, averaged in the same way. It may be urged that this would tend to obscure any epidemic that might occur. But as the duration of this disease varies between six months and twenty years, with an average of two to three years, the yearly variations in the deaths can be readily accounted for by the accidental falling together of a number which had started at different times. The proof of an epidemic will have to be made from the clinical observation of the commencement of particular cases rather than from general mortality statistics.

Tables four and five give the death-rate and per cent. of cancer deaths to deaths from all causes, calculated from the previous tables, for the same periods. If these figures for any year are plotted into two curves on the same sheet they form a "graphic picture" which is characteristic of the disease. The death-rate is estimated on the basis of one million persons for each decade.

The figures for Massachusetts are as follows between 1870 and 1895: —

MASSACHUSETTS.

Increase of Cancer (Percentage of Total Mortality).

[Ratio of the percentages of 1895 to those of 1870.]

Ages.											
30-40.		40-50.		50-60.		60-70.		70-80.		80-100.	
Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
2.01	1.44	1.82	1.59	1.49	1.63	1.66	1.48	1.43	1.63	1.61	1.35

Increase of Cancer Death-rates.

[Ratio of the cancer death-rates of 1895 to those of 1870.]

1.91	1.26	1.99	1.64	1.81	2.02	2.01	1.85	1.61	1.83	1.65	1.41

The foregoing results were obtained by dividing the figures of 1895 by those of 1870 for each age period.

Proportion of Cancer Mortality Percentages, Females to Males.

Year.	Ages. 30-40.	40-50.	50-60.	60-70.	70-80.	80-100.
1870, ...	4.31	4.02	2.45	1.85	1.32	1.30
1895, ...	3.07	3.53	2.60	1.67	1.55	1.08

Proportion of Cancer Death-rates, Females to Males.

1870, ...	4.36	3.77	2.05	1.51	1.15	1.13
1895, ...	2.92	3.27	2.23	1.40	1.31	0.98

The first two show that on the whole there has been a greater increase among the males than the females, pointing to the fact of improved diagnosis. The last two show that the greatest disparity between the females and the males is in the earlier years of life, while towards the end there is an equality.

A very interesting comparison can be made with Austria, showing the smaller proportion of females in the earlier decades.

Proportion of Cancer Death-rates, Females to Males (1895).

	Ages.				
	30-40.	40-50.	50-60.	60-70.	70-100.
Austria,	2.02	1.56	1.09	0.94	1.00
Massachusetts,	2.92	3.27	2.23	1.40	1.23

It shows the same tendency as in Massachusetts to equality in the last decades, but there is not so great difference in the earlier ones.

Table six gives the statistics of the New England States, Michigan, England and Austria for the year 1895 for purpose of comparison.

A single quinquennium has been taken, and this is the latest, as the records for the earlier years are not reliable in the other States. England is also averaged for five years, while Michigan and Austria are computed on a single year, these being the only statistics available.

With the exception of Maine the other New England States show lower death-rates and mortality percentages in general, which makes the average for New England, as a whole, a little lower than that of Massachusetts.

Michigan has a very high death-rate from cancer, but the statistics, although well arranged and presented, are only for a single year. In view of the extremely low general death-rate, it is probable that the returns are incomplete, and it will be several years before they can be safely accepted.

In studying the curves of the mortality percentage there seems to be a distinct male and female type. The latter starts higher than the male, has a very much higher apex at an earlier decade, and rapidly descends to and below its starting point close to the male. The male starts low, its apex is rounded and falls off gradually, to terminate higher than it commenced. The curve for "persons" is naturally a combination of these two, but as the female is the stronger marked it has more of that characteristic. In all of the States and England the curves have the same characteristic, but in Austria the difference between the male and female curve is much less marked, and their apices are at the same decade, 50 to 60, instead of the males being later.

The death-rate for cancer for persons of all ages over thirty years is for Austria wonderfully close to Massachusetts, being 1,500 and 1,495, respectively, but the mortality percentage varies somewhat, being 6.55 for Massachusetts against 5.76 for Austria. This means, however, that the death-rate for all ages over thirty, for Austria, is higher than for Massachusetts. Since the death-rate for a disease can always be found by multiplying the general death-rate by the mortality percentage for the disease, or, conversely, the mortality percentage can be found by dividing the general death-rate by the rate for the disease.

In the above case the general death-rate of Austria for all persons over thirty years is 26.02 per thousand, or 26,020 per million; multiply this by .0576, the mortality percentage, and it gives 1,498.8, against 1,500 obtained.

In the same way the death-rate for Massachusetts, over thirty years, is 22.82, or 22,820 per million, which, multiplied by .0658, gives 1,501.5, against 1,495, easily within the ordinary limits of error. The general death-rate for persons over thirty years has been given in the table for the different States and countries.

One interesting figure in all is the per cent. of total cancer deaths over thirty years to the total cancer deaths of all ages. It is found to vary within very narrow limits in the New England States, with a maximum of 96.92 per cent. in Vermont and a minimum of 96.46 per cent. in Rhode Island.

Austria gives a per cent. of 95.89, while England gives 98.3 per cent., but it is for all ages over twenty-five, and naturally it would be higher on that account. This shows conclusively that in estimating the death-rate and mortality percentage for cancer, if all ages are employed the figures will be very misleading.

For the purpose of comparison a table is added (Table VII.) in which the death-rates from cancer in England and Wales are presented for three successive decades, 1861–1890.

TABLE I.—MASSACHUSETTS.

Population.

Year.	All Ages.			All Ages over 30.			30-40.			40-50.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
1850,	488,517	505,997	994,514	176,328	184,348	360,676	72,244	70,687	142,931	48,168	48,098	96,266
1855,	550,034	582,335	1,032,369	202,798	213,319	416,117	81,240	82,020	163,260	55,995	54,920	110,915
1860,	596,721	634,346	1,231,067	229,269	242,290	471,559	90,237	93,354	183,591	63,823	61,742	125,565
1865,	602,011	665,021	1,267,031	247,014	272,013	519,027	84,905	100,638	185,543	71,571	71,260	142,831
1870,	703,779	753,572	1,457,351	285,170	310,041	595,211	101,164	112,987	214,151	80,106	82,583	162,689
1875,	794,383	857,529	1,651,912	317,564	349,361	666,925	113,607	127,359	240,966	86,968	94,955	181,923
1880,	858,440	924,645	1,783,085	360,451	398,941	759,392	126,327	138,086	264,413	97,442	106,073	203,515
1885,	932,884	1,009,257	1,942,141	394,769	438,500	833,269	138,425	148,794	287,219	106,725	116,195	222,920
1890,	1,087,709	1,151,234	2,238,943	460,874	500,004	960,878	168,157	173,465	341,622	122,921	130,260	253,181
1895,	1,214,701	1,285,482	2,500,183	523,003	564,227	1,087,230	198,441	201,693	400,134	138,379	144,402	282,781

Population — Concluded.

Year.	50-60.			60-70.			70-80.			80-100.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
1850,	28,624	31,630	60,254	16,872	19,965	36,837	7,845	10,091	17,936	2,575	3,877	6,452
1855,	34,027	36,826	70,853	19,793	23,561	43,354	9,025	11,709	20,734	2,717	4,281	6,998
1860,	39,430	42,023	81,453	22,715	27,157	49,872	10,205	13,328	23,533	2,859	4,686	7,545
1865,	48,176	48,270	96,446	27,702	31,514	59,216	11,464	15,211	26,675	3,196	5,120	8,316
1870,	53,964	54,384	108,348	32,427	35,974	68,401	13,845	18,050	31,895	3,664	6,063	9,727
1875,	60,924	57,506	118,430	35,113	41,073	76,186	16,869	21,414	38,283	4,083	7,054	11,127
1880,	68,195	73,858	142,053	43,871	47,748	91,619	19,595	24,742	44,337	5,091	8,434	13,525
1885,	73,792	82,968	156,760	47,987	53,632	101,619	21,948	27,287	49,235	5,892	9,624	15,516
1890,	83,782	94,349	178,131	53,539	60,633	114,172	25,541	30,345	55,886	6,934	10,952	17,886
1895,	94,232	105,279	199,511	57,067	68,216	125,283	27,601	33,410	61,011	7,283	11,227	18,510

TABLE II. — MASSACHUSETTS — *Continued.*

Deaths from All Causes (Average of Five Years).

Year.	All Ages.			All Ages over 30.			30-40.			40-50.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
1850,	8,099	8,359	16,606	3,159	3,318	6,580	729	884	1,613	613	576	1,189
1855,	10,285	10,386	20,798	3,999	4,210	8,210	826	979	1,805	721	647	1,368
1860,	11,444	11,547	23,068	4,519	4,910	9,351	907	1,029	1,936	801	724	1,526
1865,	13,085	13,024	26,152	5,238	5,510	10,924	1,088	1,134	2,222	938	837	1,775
1870,	14,209	14,142	28,351	5,933	6,492	12,425	1,058	1,232	2,290	983	975	1,958
1875,	16,479	16,551	33,061	6,851	7,362	14,213	1,185	1,397	2,582	1,108	1,099	2,207
1880,	17,028	17,338	34,366	7,788	8,474	16,262	1,243	1,486	2,729	1,178	1,250	2,428
1885,	19,012	19,153	38,165	9,109	9,811	18,921	1,461	1,609	3,070	1,413	1,426	2,839
1890,	22,258	22,011	44,269	10,893	11,584	22,477	1,768	1,779	3,547	1,671	1,675	3,340
1895,	24,401	23,642	48,043	12,171	12,634	24,805	1,985	1,921	3,907	1,847	1,761	3,608

Deaths from All Causes (Average of Five Years) — Concluded.

Year.	50-60.			60-70.			70-80.			80-100.		
	Males.	Females	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
1850,	546	508	1,054	546	570	1,116	540	625	1,165	438	618	1,056
1855,	658	558	1,205	645	625	1,271	757	625	1,382	467	660	1,127
1860,	733	651	1,384	744	731	1,476	762	819	1,581	478	717	1,195
1865,	874	768	1,642	946	926	1,872	890	1,017	1,907	577	855	1,432
1870,	1,002	844	1,846	1,142	1,044	2,186	1,066	1,193	2,259	681	1,016	1,697
1875,	1,150	1,037	2,187	1,361	1,254	2,615	1,309	1,410	2,719	735	1,163	1,898
1880,	1,264	1,208	2,472	1,553	1,434	2,987	1,587	1,670	3,257	964	1,423	2,387
1885,	1,469	1,513	2,982	1,911	1,739	3,650	1,809	1,907	3,716	1,110	1,616	2,726
1890,	1,832	1,817	3,649	2,158	2,216	4,374	2,195	2,267	4,462	1,304	1,946	3,250
1895,	2,115	2,022	4,137	2,441	2,465	4,906	2,399	2,474	4,873	1,384	1,955	3,340

TABLE III. — MASSACHUSETTS — *Continued.*

Deaths from Cancer (Average of Five Years).

Year.	All Ages.			All Ages over 30.			30-40.			40-50.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
1850,	59	93	152	52	82	134	3	8	11	5	17	22
1855,	78	141	219	68	130	198	2	14	16	8	26	34
1860,	101	216	317	95	200	295	7	16	23	14	39	53
1865,	117	250	367	101	237	338	6	23	29	10	48	58
1870,	164	344	508	152	332	484	8	40	48	18	73	91
1875,	188	430	618	178	417	595	8	41	49	21	91	112
1880,	296	610	906	287	597	884	16	57	73	32	132	164
1885,	341	748	1,089	331	735	1,066	16	62	78	40	131	171
1890,	428	928	1,356	415	906	1,331	17	79	96	47	179	226
1895,	541	1,136	1,677	521	1,104	1,625	30	90	120	62	210	272

Deaths from Cancer (Average of Five Years) — Concluded.

Year.	50-60.			60-70.			70-80.			80-100.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
1850,	10	19	29	12	14	26	14	15	29	8	7	15
1855,	17	30	47	17	28	45	15	21	36	7	9	16
1860,	19	55	74	23	43	66	22	31	53	8	14	22
1865,	19	63	82	32	58	90	23	33	56	9	10	19
1870,	38	78	116	46	78	124	33	50	83	11	21	32
1875,	36	96	132	58	98	156	41	65	106	12	21	33
1880,	65	154	219	79	122	201	69	86	155	18	32	50
1885,	65	186	251	95	166	261	78	113	191	26	42	68
1890,	94	240	334	128	207	335	94	145	239	32	55	87
1895,	122	305	427	163	273	436	106	169	276	36	55	91

TABLE IV.—MASSACHUSETTS—*Continued.*

Annual Death-rate from Cancer for 1,000,000 Living at Each Age.

Year.	All Ages.			All Ages over 30.			30-40.			40-50.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
1850,	121	184	153	295	445	372	41	113	77	104	359	229
1855,	144	247	196	335	609	476	25	171	98	143	473	307
1860,	169	344	257	414	825	626	76	171	125	219	632	422
1865,	194	376	290	409	871	651	71	228	156	140	674	406
1870,	233	456	349	533	1,071	813	79	354	224	225	884	559
1875,	237	501	374	561	1,193	892	70	322	203	241	953	615
1880,	345	660	508	796	1,496	1,167	126	413	276	328	1,244	806
1885,	366	741	561	838	1,676	1,279	116	417	272	375	1,127	767
1890,	393	806	605	900	1,812	1,385	101	455	281	382	1,374	893
1895,	445	884	670	996	1,956	1,495	151	446	280	448	1,454	962

Annual Death-rate from Cancer for 1,000,000 Living at Each Age—Concluded.

Year.	50-60.			60-70.			70-80.			80-100.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
1850,	349	601	481	711	711	706	1,783	1,486	1,616	3,101	1,805	2,326
1855,	499	814	663	859	1,188	1,038	1,662	1,793	1,736	2,576	2,102	2,286
1860,	482	1,309	908	1,012	1,582	1,333	2,155	2,326	2,253	2,797	2,985	2,914
1865,	394	1,305	850	1,155	1,841	1,520	2,007	2,170	2,099	2,813	1,953	2,283
1870,	704	1,434	1,071	1,418	2,168	1,813	2,384	2,762	2,602	3,005	3,465	3,239
1875,	591	1,669	1,115	1,652	2,384	2,048	2,430	3,036	2,769	2,941	2,979	2,965
1880,	953	2,085	1,542	1,586	2,555	2,194	3,520	3,476	3,496	3,536	3,796	3,695
1885,	881	2,242	1,601	1,980	3,095	2,568	3,553	4,140	3,879	4,414	4,466	4,375
1890,	1,122	2,544	1,875	2,391	3,414	2,934	3,680	4,778	4,276	4,617	5,028	4,304
1895,	1,273	2,897	2,140	2,856	4,002	3,480	3,840	5,058	4,524	4,945	4,898	4,916

TABLE V. — MASSACHUSETTS — *Concluded.*

Per Cent. of Cancer Deaths to Total Deaths.

Year.	All Ages.			All Ages over 30.			30-40.			40-50.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
1850,	0.73	1.11	0.91	1.65	2.47	2.04	0.41	0.90	0.68	0.81	2.95	1.84
1855,	0.76	1.36	1.05	1.70	3.09	2.41	0.24	1.43	0.88	1.11	4.02	2.49
1860,	0.88	1.68	1.37	2.10	4.07	3.16	0.77	1.55	1.18	1.75	5.39	3.47
1865,	0.89	1.92	1.40	1.93	4.30	3.09	0.55	2.03	1.30	1.07	5.73	3.26
1870,	1.15	2.43	1.79	2.56	5.12	3.90	0.75	3.25	2.10	1.83	7.49	4.65
1875,	1.14	2.60	1.87	2.60	5.66	4.18	0.68	2.93	1.90	1.89	8.27	5.08
1880,	1.74	3.52	2.64	3.69	7.05	5.43	1.29	3.82	2.67	2.72	10.56	6.75
1885,	1.79	3.91	2.85	3.63	7.49	5.63	1.09	3.85	2.54	2.83	9.19	6.02
1890,	1.92	4.22	3.06	3.81	7.82	5.92	0.96	4.44	2.70	2.81	10.68	6.76
1895,	2.21	4.81	3.49	4.28	8.74	6.55	1.51	4.68	3.07	3.35	11.92	7.54

Per Cent. of Cancer Deaths to Total Deaths — Concluded.

Year.	50-60.			60-70.			70-80.			80-100.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
1850,	1.83	3.74	2.75	2.20	2.46	2.33	2.59	2.40	2.49	1.83	1.13	1.42
1855,	2.58	5.38	3.90	2.64	4.48	3.54	1.98	3.36	2.60	1.50	1.36	1.42
1860,	2.69	8.45	5.34	3.09	5.88	4.47	2.88	3.79	3.35	1.68	1.95	1.84
1865,	2.17	8.20	4.99	3.38	6.26	4.81	2.59	3.24	2.94	1.56	1.17	1.32
1870,	3.89	9.24	6.28	4.03	7.47	5.67	3.09	4.19	3.67	1.62	2.07	1.89
1875,	3.13	9.25	6.04	4.26	7.81	5.96	3.13	4.61	3.90	1.63	1.81	1.74
1880,	5.14	12.75	8.86	5.09	8.50	6.72	4.35	5.15	4.75	1.87	2.25	2.10
1885,	4.42	12.29	8.41	4.97	9.54	7.15	4.32	5.92	5.13	2.34	2.60	2.49
1890,	5.13	13.20	9.15	5.93	9.34	7.65	4.28	6.40	5.36	2.45	2.82	2.67
1895,	5.76	15.08	10.32	6.68	11.09	8.87	4.42	6.83	5.67	2.60	2.81	2.72

TABLE VI.—COMPARISON OF DEATH-RATES AND MORTALITY PERCENTAGES FROM CANCER.

MAINE.

YEAR.—1895.	ALL AGES.			ALL AGES OVER 30.			30-40.			40-50.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	178	295	473	-	-	457	-	-	26	-	-	59
Population,	337,840	341,934	679,774	-	-	311,568	-	-	92,935	-	-	74,788
Death-rate per million,	527	863	696	-	-	1,466	-	-	280	-	-	790
Total deaths,	5,465	5,415	10,894	-	-	6,792	304	419	724	317	382	699
Per cent. of total mortality,	3.26	5.45	4.35	-	-	6.73	-	-	3.6	-	-	8.44

MAINE—*Concluded.*

YEAR.—1895.	50-60.			60-70.			70-80.			80-100.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	-	-	102	-	-	121	-	-	110	-	-	39
Population,	-	-	64,852	-	-	43,655	-	-	25,760	-	-	9,578
Death-rate per million,	-	-	1,574	-	-	2,772	-	-	4,270	-	-	4,071
Total deaths,	457	450	908	721	627	1,349	928	792	1,721	657	733	1,391
Per cent. of total mortality,	-	-	11.23	-	-	8.97	-	-	6.39	-	-	2.8

Proportion of cancer deaths over 30 years to total cancer deaths, 96.62 per cent. General death-rate over 30 years, 21.79 per 1,000.

TABLE VI. — COMPARISON OF DEATH-RATES AND MORTALITY PERCENTAGES FROM CANCER — *Continued.*

NEW HAMPSHIRE.

YEAR. — 1895.	ALL AGES.			ALL AGES OVER 30.			30-40.			40-50.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	91	172	263	84	172	256	2	13	15	6	29	35
Population,	195,693	198,356	394,059	91,774	96,099	185,989	29,207	27,826	57,033	22,165	22,481	44,746
Death-rate per million,	462	866	665	915	1,790	1,376	61	467	263	270	1,289	782
Total deaths,	3,456	3,532	6,982	2,049	2,209	4,261	202	253	455	208	236	445
Per cent. of total mortality,	2.63	4.86	3.80	4.09	7.75	6.01	.99	5.13	3.27	2.88	12.28	7.86

NEW HAMPSHIRE — *Concluded.*

YEAR. — 1895.	50-60.			60-70.			70-80.			80-100.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	10	42	52	26	39	65	29	32	61	10	13	23
Population,	17,535	19,013	36,548	12,934	13,512	26,472	7,505	7,839	15,344	2,428	3,428	5,846
Death-rate per million,	570	2,209	1,422	2,010	2,886	2,456	3,864	4,081	3,976	4,118	3,792	3,934
Total deaths,	277	299	576	430	405	836	554	533	1,087	378	483	862
Per cent. of total mortality,	3.61	14.05	9.02	6.04	9.62	7.77	5.23	6.00	5.6	2.7	2.70	2.67

Proportion of cancer deaths over 30 years to total cancer deaths, 96.58 per cent. General death-rate over 30 years, 22.91 per 1,000.

TABLE VI. — COMPARISON OF DEATH-RATES AND MORTALITY PERCENTAGES FROM CANCER — *Continued.*

VERMONT.

YEAR. — 1895.	ALL AGES.			ALL AGES OVER 30.			30-40.			40-50.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	67	128	195	-	-	189	-	-	9	-	-	26
Population,	172,185	165,845	338,030	-	-	156,610	-	-	45,057	-	-	38,283
Death-rate per million,	390	772	577	-	-	1,206	-	-	199	-	-	678
Total deaths,	2,784	2,665	5,466	-	-	3,384	-	-	327	-	-	340
Per cent. of total mortality,	2.41	4.80	3.56	-	-	5.6	-	-	2.75	-	-	7.64

VERMONT — *Concluded.*

YEAR. — 1895.	50-60.			60-70.			70-80.			80-100.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	-	-	40	-	-	48	-	-	46	-	-	19
Population,	-	-	31,787	-	-	22,230	-	-	13,732	-	-	5,531
Death-rate per million,	-	-	1,258	-	-	2,159	-	-	3,357	-	-	3,435
Total deaths,	-	-	450	-	-	635	-	-	896	-	-	736
Per cent of total mortality,	-	-	8.88	-	-	7.56	-	-	5.13	-	-	2.58

Proportion of cancer deaths over 30 years to total cancer deaths, 96.92 per cent. General death-rate over 30 years, 21.61 per 1,000.

TABLE VI.—COMPARISON OF DEATH-RATES AND MORTALITY PERCENTAGES FROM CANCER—*Continued.*

MASSACHUSETTS.

YEAR.—1895.	ALL AGES.			ALL AGES OVER 30.			30-40.			40-50.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	541	1,136	1,677	529	1,104	1,633	30	90	120	62	210	272
Population,	1,217,701	1,285,482	2,500,183	523,003	564,227	1,087,230	198,441	201,693	400,134	138,379	144,402	282,781
Death-rate per million,	445	883	670	1,011	1,956	1,502	151	446	299	448	1,454	1,319
Total deaths,	24,401	23,642	48,043	12,171	12,634	24,805	1,985	1,921	3,907	1,847	1,761	3,608
Per cent. of total mortality,	2.17	4.80	3.49	4.3	8.73	6.58	1.51	4.7	3.1	3.35	11.9	7.54

MASSACHUSETTS—*Concluded.*

YEAR.—1895.	50-60.			60-70.			70-80.			80-100.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	122	305	427	162	273	435	106	169	275	36	55	91
Population,	94,232	105,279	199,511	57,067	68,212	125,283	27,601	33,410	61,011	7,283	11,227	18,510
Death-rate per million,	1,294	2,897	2,140	2,838	4,002	3,472	3,840	5,059	4,508	4,945	4,898	4,916
Total deaths,	2,115	2,022	4,137	2,441	2,465	4,906	2,399	2,474	4,873	1,384	1,955	3,340
Per cent. of total mortality,	5.76	15.00	10.37	6.65	11.10	8.86	4.42	6.83	5.64	2.60	2.81	2.72

Proportion of cancer deaths over 30 years to total cancer deaths, 96.90 per cent. General death-rate over 30 years, 22.82 per 1,000.

TABLE VI. — COMPARISON OF DEATH-RATES AND MORTALITY PERCENTAGES FROM CANCER — *Continued.*

RHODE ISLAND.

YEAR. — 1895.	ALL AGES.			ALL AGES OVER 30.			30-40.			40-50.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	66	160	226	63	155	218	3	15	18	8	32	40
Population,	188,310	198,721	387,301	77,836	83,698	161,535	28,106	29,353	57,439	21,843	22,374	44,214
Death-rate per million,	350	805	583	810	1,852	1,349	106	511	313	367	1,430	904
Total deaths,	3,722	3,628	7,350	1,815	1,906	3,721	283	286	569	296	293	589
Per cent. of total mortality,	1.77	4.41	3.07	3.47	8.13	5.86	1.06	5.24	3.05	2.70	10.90	6.79

RHODE ISLAND — *Concluded.*

YEAR. — 1895.	50-60.			60-70.			70-80.			80-100.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	14	38	52	19	36	55	13	24	37	5	8	13
Population,	14,067	16,009	30,076	8,672	9,723	18,395	4,079	4,680	8,759	1,069	1,582	2,652
Death-rate per million,	995	2,373	1,728	2,190	3,702	3,044	3,186	5,120	4,223	4,673	5,057	4,901
Total deaths,	334	309	643	371	392	763	346	358	704	185	268	453
Per cent. of total mortality,	4.2	12.29	8.1	5.12	9.18	7.20	3.75	6.70	5.25	2.70	2.98	2.86

Proportion of cancer deaths over 30 years to total cancer deaths, 96.46 per cent. General death-rate over 30 years, 23.04 per 1,000.

TABLE VI. — COMPARISON OF DEATH-RATES AND MORTALITY PERCENTAGES FROM CANCER — *Continued.*

CONNECTICUT.

YEAR. — 1895.	ALL AGES.			ALL AGES OVER 30.			30-40.			40-50.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	147	306	453	-	-	438	-	-	30	-	-	79
Population,	401,416	406,621	808,037	-	-	351,498	-	-	120,270	-	-	90,514
Death-rate per million,	366	752	560	-	-	1,204	-	-	249	-	-	873
Total deaths,	7,450	6,946	14,417	-	-	7,969	-	-	1,127	-	-	1,060
Per cent. of total mortality,	1.97	4.41	3.14	-	-	5.50	-	-	2.66	-	-	7.45

CONNECTICUT — *Concluded.*

YEAR. — 1895.	50-60.			60-70.			70-80.			80-100.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	-	-	107	-	-	117	-	-	73	-	-	30
Population,	-	-	65,506	-	-	44,726	-	-	22,706	-	-	7,776
Death-rate per million,	-	-	1,633	-	-	2,615	-	-	3,214	-	-	3,858
Total deaths,	-	-	1,287	-	-	1,589	-	-	1,686	-	-	1,216
Per cent. of total mortality,	-	-	8.31	-	-	7.36	-	-	4.32	-	-	2.46

Proportion of cancer deaths over 30 years to total cancer deaths, 96.69 per cent. General death-rate over 30 years, 22.67 per 1,000.

TABLE VI — COMPARISON OF DEATH-RATES AND MORTALITY PERCENTAGES FROM CANCER — *Continued.*

NEW ENGLAND STATES.

YEAR.—1895.	ALL AGES.			ALL AGES OVER 30.			30-40.			40-50.		
	Males.	Females.	Persons	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	1,092	2,198	3,290	-	-	3,183	-	-	219	-	-	407
Population,	2,510,145	2,596,959	5,107,104	-	-	2,254,430	-	-	772,835	-	-	575,329
Death-rate per million,	435	846	644	-	-	1,412	-	-	283	-	-	707
Total deaths,	47,281	45,828	93,152	-	-	50,931	-	-	7,109	-	-	6,741
Per cent. of total mortality,	2.30	4.80	3.53	-	-	6.25	-	-	3.09	-	-	6.14

NEW ENGLAND STATES — *Concluded.*

YEAR.—1895.	50-60.			60-70.			70-80.			80-100.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	-	-	782	-	-	844	-	-	605	-	-	218
Population,	-	-	427,339	-	-	280,751	-	-	147,312	-	-	49,893
Death-rate per million,	-	-	1,825	-	-	3,005	-	-	4,115	-	-	4,369
Total deaths,	-	-	8,001	-	-	10,087	-	-	10,967	-	-	7,798
Per cent. of total mortality,	-	-	9.77	-	-	8.36	-	-	5.52	-	-	2.79

Proportion of cancer deaths over 30 years to total cancer deaths, 96.75 per cent. General death-rate over 30 years, 22.60 per 1,000.

TABLE VI. — COMPARISON OF DEATH-RATES AND MORTALITY PERCENTAGES FROM CANCER — *Continued.*

MICHIGAN.

YEAR. — 1898.	ALL AGES.			ALL AGES OVER 30.			30-40.			40-50.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	549	772	1,321	524	738	1,262	35	63	98	56	126	182
Population,	1,229,299	1,160,094	2,389,393	505,914	449,584	995,498	181,406	165,356	346,762	136,060	115,398	251,458
Death-rate per million,	446	666	553	1,036	1,641	1,268	193	381	282	412	1,092	724
Total deaths,	14,806	13,273	28,174	8,518	7,568	16,086	927	1,107	2,034	1,065	938	2,003
Per cent. of total mortality,	3.71	5.82	4.69	6.15	9.75	7.84	3.78	5.69	4.82	5.26	13.3	9.09

MICHIGAN — *Concluded.*

YEAR. — 1898.	50-60.			60-70.			70-80.			80-100.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	121	204	325	155	184	339	122	117	239	35	44	79
Population,	94,474	85,969	180,443	59,445	53,631	113,076	28,191	23,405	51,596	6,338	5,825	12,163
Death-rate per million,	1,281	2,372	1,801	2,607	3,430	2,998	4,327	4,998	4,632	5,522	7,553	6,495
Total deaths,	1,326	1,161	2,487	1,796	1,511	3,307	2,142	1,719	3,861	1,262	1,132	2,394
Per cent. of total mortality,	9.1	17.57	13.06	8.6	12.17	10.25	5.69	6.80	6.19	2.77	3.88	3.30

Proportion of cancer deaths over 30 years to total cancer deaths, 95.53 per cent. General death-rate over 30 years, 16.16 per 1,000.

TABLE VI.—COMPARISON OF DEATH-RATES AND MORTALITY PERCENTAGES FROM CANCER—*Continued.*

ENGLAND AND WALES

YEAR.—1885.	ALL AGES.			ALL AGES OVER 25.			25-35.			35-45.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths, ...	5,743	10,448	16,191	5,595	10,317	15,912	154	367	521	450	1,381	1,831
Population, ...	13,346,491	14,142,081	27,488,482	5,899,701	6,530,001	12,431,702	1,955,274	2,130,321	4,085,595	1,514,486	1,620,293	3,134,779
Death-rate per million, . . .	430	739	589	948	1,580	1,280	79	172	127	297	852	584
Total deaths, ...	269,831	254,645	524,477	135,356	135,814	271,170	15,121	15,633	30,755	18,696	17,087	35,783
Per cent. of total mortality, . .	2.13	4.10	3.08	4.13	7.60	5.87	1.02	2.35	1.69	2.41	8.08	5.12

ENGLAND AND WALES—*Concluded.*

YEAR.—1885.	45-55.			55-65.			65-75.			75-100.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths, ...	1,109	2,497	3,606	1,716	2,859	4,575	1,562	2,269	3,831	601	942	1,543
Population, ...	1,112,527	1,222,633	2,335,160	746,339	849,206	1,595,545	417,389	503,754	921,143	153,686	205,794	359,480
Death-rate per million, . . .	997	2,042	1,544	2,299	3,366	2,867	3,742	4,504	4,160	3,910	4,578	4,292
Total deaths, ...	21,455	18,392	39,847	25,871	24,119	49,990	29,287	30,264	59,552	24,925	30,317	55,242
Per cent. of total mortallty, . .	5.16	13.56	9.05	6.63	11.81	9.15	5.33	7.49	6.43	2.41	3.10	2.72

Proportion of cancer deaths over 25 years to total cancer deaths, 98.3 per cent. General death-rate from all diseases over 25 years, 21.86 per 1,000.

TABLE VI. — COMPARISON OF DEATH-RATES AND MORTALITY PERCENTAGES FROM CANCER — *Concluded.*

AUSTRIA.

YEAR. — 1895.	ALL AGES.			ALL AGES OVER 30.			30-40.			40-50.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons	Males.	Females.	Persons.
Cancer deaths,	7,034	8,693	15,727	6,735	8,346	15,081	293	569	862	894	1,464	2,368
Population,	12,247,627	12,729,812	24,977,038	4,908,508	5,140,820	10,049,365	1,716,009	1,641,891	3,357,900	1,296,843	1,366,748	2,663,591
Death-rate per million,	574	682	620	1,372	1,623	1,500	171	347	257	689	1,070	889
Total deaths,	349,271	332,517	681,788	127,891	133,615	261,506	15,110	16,833	31,943	18,207	16,281	34,488
Per cent. of total mortality,	2.10	2.61	2.36	5.26	6.24	5.76	1.94	3.38	2.70	4.90	8.99	6.87

AUSTRIA — *Concluded.*

YEAR. — 1895.	50-60.			60-70.			70-100.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
Cancer deaths,	2,018	2,403	4,421	2,195	2,442	4,637	1,335	1,468	2,803
Population,	976,147	1,066,911	2,043,085	585,413	696,686	1,282,099	334,106	368,584	702,690
Death-rate per million,	2,067	2,252	2,163	3,749	3,505	3,616	3,995	3,982	3,988
Total deaths,	25,099	23,095	48,194	29,411	32,088	61,499	40,064	45,308	85,372
Per cent. of total mortality,	8.04	10.40	9.17	7.46	7.61	7.53	3.33	3.24	3.29

Proportion of cancer deaths over 30 years to total cancer deaths, 95.89 per cent. General death-rate over 30 years, 26.02 per 1,000.

TABLE VII.—ENGLAND AND WALES.

Annual Death-rate from Cancer per Million Living (1861-1890).

Year.	All Ages.			All Ages over 25.			25-35.			35-45.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
1861-70,	242	519	384	-	-	-	60	161	113	204	669	445
1871-80,	312	617	468	-	-	-	70	173	124	239	790	525
1881-90,	430	739	589	-	-	-	79	172	127	297	852	584

ENGLAND AND WALES—*Concluded.*

Annual Death-rate from Cancer per Million Living (1861-1890)—Concluded.

Year.	45-55.			55-65.			65-75.			75-100.		
	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.	Males.	Females.	Persons.
1861-70,	536	1,530	1,048	1,201	2,291	1,768	1,862	2,791	2,360	2,258	2,786	2,556
1871-80,	705	1,760	1,255	1,588	2,753	2,200	2,599	3,512	3,092	2,985	3,513	3,283
1881-90,	997	2,042	1,544	2,299	3,366	2,867	3,742	4,504	4,160	3,910	4,578	4,292

STATISTICAL SUMMARIES

OF

DISEASE AND MORTALITY.

[755]

STATISTICAL SUMMARIES OF DISEASE AND MORTALITY.

The statistical information relating to disease and mortality which has been received by the Board during each year, either through the medium of voluntary returns or in consequence of legal requirements, has, in the last six reports of the Board, been presented under four different heads or groups, which are summarized and defined as follows: —

I. *The Weekly Mortality Returns.* — These consist of the reports of deaths, which are made up weekly and are sent to the office of the State Board by the registration officials of cities and towns. They are voluntary, and serve principally to show the seasonal prevalence of each of the chief infectious diseases, and the mortality of children under five years old in weekly periods. This series of statistics has been continued by the Board for more than twenty years, and has been published as a summary for sixteen years.

II. *The Reports of Certain Infectious Diseases, — Diphtheria and Croup, Scarlet Fever, Typhoid Fever and Measles.* — These are obtained from the annual reports of local boards of health for the year 1900, which are forwarded to the State Board from cities and towns. By comparing the numbers of reported cases with the reported deaths, the mean fatality of each disease in the places from which the reports are made is obtained with a reasonable degree of accuracy.

III. *Reports of Cities and Towns, made under the Provisions of Chapter 302 of the Acts of 1893.* — By this act each local board of health is required to report to the State Board every case of "disease dangerous to the public health" which is reported to the local board. A digest of these reports is presented in Summary No. III.

IV. *Annual Reports, made under the Provisions of Chapter 218 of the Acts of 1894.* — The full reports of deaths occurring in each city and town having over 5,000 inhabitants comprise another series of returns, which are summarized in No. IV. These reports are made under the requirements of the following statute: —

[ACTS OF 1894, CHAPTER 218, SECTION 3.]

In each city and town having a population of more than five thousand inhabitants, as determined by the last census, at least one member of said board shall be a physician, and the board shall send an annual report of the deaths in such town to the State Board of Health. The form of such reports shall be prescribed and furnished by the State Board of Health.

NOTE. — A supply of the postal cards, necessary for the reporting of voluntary mortality returns such as are required for the data presented in section I. of the following summary, will be forwarded to the registration officers of any city or town who are willing to contribute the necessary information.

Postal cards are also sent to all boards of health in the State, for the purpose of aiding them to comply with the provisions of chapter 302 of the Acts of 1893, relative to the reporting of diseases dangerous to the public health to the State Board immediately after reports of the same are received by the local board.

Annual blank forms are also sent to each local board of health in cities and towns having over 5,000 inhabitants, for the return of such information as is called for by the provisions of chapter 218 of the Acts of 1894.

I.

The Weekly Mortality Returns.

In the following summary, the voluntary reports of deaths received at the close of each week from the city registrars, town clerks and boards of health of the cities and towns are epitomized for the year 1900. The chief value of this abstract consists in the fact that it presents a continuous history of the mortality from certain specified diseases from week to week throughout the year.

This weekly report has been published in the Boston Medical and Surgical Journal every week for a period of twenty years or more, and also as a publication of the Board, in a weekly bulletin, since and including 1883.

These returns are necessarily incomplete, since they are voluntary and consequently embrace the statistics of a portion only of the population, the reporting places being chiefly the cities and large towns.

The estimated population of the cities and towns contributing to these returns in 1900 was 1,734,615, or about two-thirds of the total population.

The following items are embraced in this summary: —

- Average height of barometer for each week.
- Mean maximum temperature.
- Mean minimum temperature.
- Rainfall, expressed in inches.
- Total deaths reported for each week.
- Deaths of children under five years.
- Deaths from infectious diseases.
- Deaths from consumption.
- Deaths from acute lung diseases.
- Deaths from typhoid fever.
- Deaths from diarrhœal diseases.
- Deaths from scarlet fever.
- Deaths from measles.
- Deaths from diphtheria and croup.
- Deaths from puerperal fever.
- Deaths from whooping-cough.
- Deaths from malarial fever.
- Deaths from erysipelas.
- Deaths from cerebro-spinal meningitis.

The following tables contain a summary of the statistics compiled from these weekly returns of mortality: —

Summary for 1900.

1900.	Barometer.	Maximum Mean Thermometer for Each Week.	Minimum Mean Thermometer for Each Week.	Humidity.	Rainfall, in Inches.*	Total Deaths.	Deaths under Five Years of Age.	Consumption.	Acute Lung Diseases.	Typhoid Fever.	Diphtheria and Croup.	Scarlet Fever.	Measles.	Diarrhœal Diseases.	Whooping-cough.	Puerperal Fever.	Malarial Fever.	Erysipelas.	Cerebro-spinal Meningitis.
Jan. 6,	30.05	31	15	66	-	571	165	57	126	3	27	12	1	2	2	-	-	2	6
13,	30.09	39	19	74	-	590	150	63	105	7	17	7	4	4	2	-	-	1	3
20,	30.15	43	29	79	-	605	163	68	110	9	27	9	4	5	3	-	-	4	12
27,	29.90	43	20	62	4.44	578	184	64	92	7	26	9	1	2	3	3	-	2	3
Feb. 3,	29.87	35	12	67	-	608	172	63	82	3	20	11	2	5	4	-	-	2	6
10,	30.09	41	27	73	-	613	200	57	101	5	25	9	2	8	4	1	-	10	5
17,	30.05	40	28	71	-	604	195	57	108	6	24	13	1	2	2	1	-	1	3
24,	29.76	39	24	74	8.14	658	201	68	123	3	25	8	2	3	5	-	-	4	3
March 3,	29.89	37	14	61	-	694	204	63	130	4	21	2	4	-	5	1	-	4	3
10,	30.20	44	25	69	-	748	200	65	180	4	20	8	1	6	3	-	-	-	11
17,	29.93	37	16	57	-	851	254	65	214	6	23	8	4	9	5	1	-	2	9
24,	29.97	46	26	61	-	938	265	112	261	6	21	5	-	5	6	2	-	7	1
31,	29.85	45	29	55	5.02	893	207	82	234	10	16	11	2	3	8	-	-	3	5
April 7,	29.71	53	36	53	-	844	211	89	191	2	17	6	2	11	5	2	-	4	6
14,	29.97	47	33	61	-	763	231	68	177	2	21	7	4	9	6	1	-	3	6
21,	30.33	56	47	65	-	693	192	69	131	7	20	4	6	10	9	-	-	5	3
28,	29.92	57	42	79	2.22	651	198	56	116	7	16	5	8	6	3	2	-	6	12
May 5,	29.83	65	45	77	-	559	153	66	95	4	12	8	6	2	6	-	-	3	4
12,	29.97	62	38	60	-	554	165	61	82	4	12	9	7	9	1	-	-	1	4
19,	29.90	61	47	88	-	636	204	78	95	8	23	11	5	10	5	-	-	9	7
26,	29.95	64	47	74	4.12	543	177	43	83	2	17	4	6	7	4	-	-	2	7
June 2,	30.07	76	55	56	-	585	214	62	86	3	22	10	5	12	5	1	-	3	9
9,	29.99	75	54	73	-	544	158	53	67	5	16	10	5	8	4	-	-	2	4
16,	30.06	77	58	64	-	488	165	49	66	2	17	5	6	20	5	-	-	1	5
23,	29.94	74	59	67	-	486	140	60	58	1	16	-	10	20	3	-	-	-	6
30,	29.72	85	63	64	2.86	535	185	50	36	3	14	3	6	44	5	-	-	-	3
July 7,	29.93	80	61	61	-	591	219	60	38	8	19	2	-	72	4	2	-	2	8
14,	29.65	84	64	66	-	598	258	61	39	5	13	3	1	106	2	-	-	2	2
21,	39.95	85	68	64	-	834	433	53	38	3	11	4	1	264	3	-	-	1	4
28,	30.00	81	65	75	2.81	721	386	57	22	4	11	2	2	237	1	-	-	-	7
Aug. 4,	30.03	80	61	64	-	678	348	55	24	6	8	5	-	211	3	-	-	1	9
11,	30.01	84	66	76	-	754	406	57	27	7	12	3	2	235	10	-	-	-	11
18,	30.01	75	61	86	-	682	293	61	16	10	13	1	-	196	8	2	-	-	4
25,	29.90	76	61	80	2.61	662	300	57	26	12	9	3	4	168	9	-	-	-	4

Sept. 1,	30.07	81	68	73	-	668	308	51	25	10	9	3	4	145	10	2	-	1	5
8,	30.30	83	65	71	-	642	286	50	45	14	22	2	-	127	7	-	-	-	10
15,	29.96	75	59	69	-	589	294	43	25	12	15	4	-	141	6	-	-	1	6
22,	29.96	65	51	73	3.37	640	297	60	41	7	22	4	3	118	-	-	-	-	1
29,	30.12	68	54	83	-	593	253	50	31	12	22	1	1	80	6	-	-	-	2
Oct. 6,	30.28	59	61	93	-	541	227	56	35	15	21	5	-	88	-	-	-	-	4
13,	30.05	64	51	83	-	523	216	45	33	16	35	3	-	67	2	-	-	-	5
20,	30.05	61	41	66	-	502	173	57	25	13	20	3	1	37	3	1	-	-	3
27,	30.27	69	52	82	3.77	559	185	65	24	15	39	6	-	36	4	-	-	-	3
Nov. 3,	30.29	57	47	87	-	486	150	48	48	14	24	2	-	32	2	-	-	-	4
10,	29.81	56	41	79	-	536	189	64	64	8	25	10	3	26	1	1	1	-	3
17,	30.09	45	31	71	-	526	152	64	57	9	40	6	1	13	1	-	-	-	2
24,	30.07	58	40	83	5.06	518	133	60	43	12	35	7	-	10	3	-	-	2	2
Dec. 1,	30.00	42	33	89	-	540	165	50	50	12	41	4	1	11	2	-	1	1	5
8,	30.00	45	33	80	-	525	151	61	67	7	27	1	2	8	3	1	-	6	10
15,	30.08	31	17	74	-	484	149	47	72	7	25	2	1	5	5	2	1	2	2
22,	30.14	40	23	66	-	515	165	45	91	14	33	8	1	4	2	-	-	-	4
29,	29.95	44	30	72	2.52	548	136	51	78	20	21	6	1	3	7	-	-	4	5
Totals,	-	-	-	-	46.94	32,287	11,225	3,116	4,233	395	1,087	294	133	2,662	217	26	3	104	271
Weekly averages,	-	-	-	-	-	621	216	60	81	7.6	21	5.6	2.6	51	4.2	.5	.06	2	5.2
Rate per 1,000 deaths,	-	-	-	-	-	-	347.66	96.5	131.1	12.95	336.67	9.1	4.12	82.11	6.17	.8	.09	3.22	8.4
Rate per 1,000 population,	-	-	-	-	-	18.61	6.47	1.80	2.44	.23	.62	.16	.077	1.53	.12	.015	.002	.06	.16

Average reporting population, ... 1,734,615

* Rainfall in inches. The figures in this column are given by months instead of weeks.

Condensed Statistics relative to the Total Deaths, Deaths under Five Years and Deaths from Certain Causes in Reporting Cities and Towns of Massachusetts in 1900.

	Deaths.	Average Number of Deaths in Each Week.	Percentage of Total Mortality.	Death-rate per 1,000 of Reporting Population.
Total deaths,	32,287	621	100	18.61
Deaths under five years,	11,225	216	34.8	6.47
Deaths from consumption,	3,116	60	9.6	1.80
Deaths from acute lung diseases,	4,233	81	13.1	2.44
Deaths from diarrhœal diseases,	2,662	51	8.2	1.53
Deaths from typhoid fever,	395	7.6	1.3	.23
Deaths from diphtheria and croup,	1,087	21	3.4	.62
Deaths from scarlet fever,	294	5.6	.9	.17
Deaths from measles,	133	2.6	.4	.08
Deaths from cerebro-spinal meningitis,	271	5.2	.8	.16
Deaths from whooping-cough,	217	4.2	.6	.12
Deaths from puerperal fever,	26	.5	.08	.015
Deaths from malarial fever,	3	.06	.009	.002
Deaths from erysipelas,	104	2	.3	.06

The usual observations upon the weekly mortality statistics have been omitted this year and the foregoing short table containing the essential statistics supplies their place. The omission is made because information of the same character is presented in a different form in Section IV. of these summaries. The chief difference consists in the fact that the information given in this section (I.) is entirely voluntary, while that of Section IV. is required by statute. The population which furnishes the statistics presented in Section IV. is considerably larger than that embraced in Section I., but both populations consist of the more densely settled parts of the State.

Meteorology.

The principal points of sanitary interest in the meteorology of Massachusetts for the year 1900 were the following: —

The mean temperature for the year was above the normal. That of each month in the year was also above the normal, except in March, April and May. This excess in the summer months probably accounts for the considerable increase in the death-rate from

cholera infantum in 1900. An examination of the records of the Board for the past ten years shows that the mean temperature of the four months June, July, August and September for the years 1891, 1892 and 1896 was above the normal of these months, and in those years the mortality from cholera infantum was excessive, while the mean temperature of the same months in 1893 and 1895 was below the normal, and in these months cholera infantum was less destructive than the average of a series of years.

The annual rainfall was but little in excess of the normal precipitation, or average of a long series of years, but its distribution throughout the year was very irregular, that of the first three months being greatly in excess of the average, while that of the remaining months was, generally, slightly less.

II.

Fatality of Certain Diseases.

The following tabular statement has been published annually since and including 1891. It consists of the statistics presented relative to the principal notifiable diseases in those cities and towns from which annual reports have been sent by the local boards of health to the State Board.

By comparing the deaths from each one of the four diseases enumerated in the table with the reported cases, a fairly accurate estimate may be obtained of the fatality of these diseases. It should be borne in mind, however, that the system of reporting cases is probably not quite so thoroughly carried out as the registration of deaths, the latter having been in force for more than a half century. Hence it is quite probable that the general fatality percentage is a little too high for each disease.

Cases of Certain Infectious Diseases and Deaths from the Same as reported to Local Boards of Health, Massachusetts, 1900.

City or Town.	Diphtheria and Croup.		Scarlet Fever.		Typhoid Fever.		Measles.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Acushnet,*	-	-	1	1	-	-	11	-
Amesbury,†	9	2	26	-	41	5	210	-
Arlington, ...	56	3	33	-	9	-	57	-
Attleborough,‡	20	4	6	-	12	1	43	2
Belmont, ...	13	2	4	-	-	-	7	-
BEVERLY, ...	20	1	37	2	41	2	77	-
BOSTON,§	4,977	537	1,710	181	730	143	2,756	88
BROCKTON, ...	135	20	25	2	52	18	290	-
Brookline, ...	247	11	29	-	16	2	66	3
CAMBRIDGE, ...	925	72	176	9	111	15	138	-
Canton, ...	2	-	-	-	-	-	2	-

* Small-pox, 2 cases.
† Whooping cough, 4 cases; 1 death.
‡ Small-pox, 1 case.
§ Small-pox, 7 cases.

Cases of Certain Infectious Diseases and Deaths from the Same as reported to Local Boards of Health, Massachusetts, 1900 — Continued.

City or Town.	Diphtheria and Croup.		Scarlet Fever.		Typhoid Fever.		Measles.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Chelmsford,	1	-	4	-	1	-	2	-
CHELSEA,	248	29	44	-	19	7	117	1
Clinton,	33	4	18	-	11	1	143	2
Cohasset,	1	-	4	1	1	-	1	-
Concord,	17	2	12	-	3	-	5	-
Danvers,	43	3	8	-	5	1	6	-
Dedham,	12	-	14	-	1	-	6	-
Easthampton,	11	3	20	1	-	-	40	-
EVERETT,	237	19	63	-	34	4	111	-
FALL RIVER,*	71	18	86	20	68	15	-	-
FITCHBURG,	104	13	97	3	58	10	125	1
Franklin,	-	-	58	-	27	-	-	-
Gardner,†	23	6	6	1	1	1	-	-
Great Barrington,	8	2	13	1	-	-	-	-
Greenfield,	8	1	54	-	15	1	6	-
HAVERHILL,	83	11	123	1	112	6	37	-
Hingham,	4	-	13	-	-	-	-	-
HOLYOKE,	313	63	214	6	25	9	504	23
Hudson,	11	1	4	-	2	1	218	-
Hyde Park,	14	3	40	1	13	1	18	-
Ipswich,	6	-	3	-	16	3	3	-
Lancaster,	4	-	1	-	-	-	-	-
LAWRENCE,	368	60	162	2	135	20	756	4
Lee,	2	-	9	-	1	2	-	-
Leicester,	2	-	4	-	1	1	123	-
Lenox,	-	-	6	-	4	-	-	-
Leominster,	39	7	41	2	5	2	65	-
Lexington,	4	-	16	-	4	-	10	-
LOWELL,‡	157	27	80	-	85	17	114	1
LYNN,	491	32	122	2	51	13	-	-
MALDEN,§	140	17	164	4	53	7	457	-
Manchester,	4	1	21	-	-	-	-	-
Marblehead,	36	2	7	-	8	2	9	-
MARLBOROUGH,	22	3	18	-	11	-	515	-

* Small-pox, 40 cases; 1 death.
† Small-pox, 6 cases.
‡ Small-pox, 23 cases.
§ Small-pox, 2 cases.

Cases of Certain Infectious Diseases and Deaths from the Same as reported to Local Boards of Health, Massachusetts, 1900 — Continued.

City or Town.	Diphtheria and Croup.		Scarlet Fever.		Typhoid Fever.		Measles.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Medford,*.	90	10	209	-	27	3	200	2
Middleborongh,†	14	-	12	-	-	-	-	-
Millbury, ...	5	-	18	-	2	-	51	-
Milton, ...	22	2	19	-	13	1	53	-
Natick, ...	12	3	2	-	3	3	5	-
New Bedford,‡	25	5	363	14	132	22	369	6
Newton, ...	361	28	117	1	42	9	406	-
North Adams, ...	12	2	31	2	66	5	20	1
North Andover, ...	11	-	7	-	5	-	12	-
Northampton, ...	33	-	102	-	64	3	109	1
North Attleborough, ...	17	2	7	-	2	-	4	1
Norwood, ...	23	-	4	-	44	-	6	-
Palmer, ...	64	-	18	-	8	-	41	-
Pittsfield, ...	42	4	116	3	-	-	-	-
Plymouth, ...	1	-	11	-	4	-	31	-
Quincy, ...	224	17	39	-	40	4	25	1
Reading, ...	7	-	36	-	8	-	20	-
Revere, ...	94	8	17	-	-	-	-	-
Rockland, ...	-	-	6	-	6	-	13	-
Salem, ...	182	24	90	4	40	7	478	1
Saugus, ...	11	-	6	-	-	-	-	-
Sharon, ...	-	-	-	-	1	-	4	-
Somerville, ...	520	49	231	7	72	9	-	-
Springfield, ...	299	24	131	2	74	17	210	5
Stoneham, ...	25	2	21	3	6	2	3	-
Swampscott, ...	15	1	9	-	1	-	2	-
Taunton,§	23	3	29	-	14	8	56	-
Wakefield, ...	56	5	40	4	7	3	22	-
Walpole, ...	1	-	-	-	5	-	1	-
Waltham, ...	435	24	50	-	43	5	19	-
Ware, ...	2	1	16	-	4	-	-‖	-
Watertown,§	79	6	18	1	17	5	15	-
Wayland, ...	1	-	1	-	-	-	4	-

* Erysipelas, 51 cases; 14 deaths.
† Small-pox, 3 cases.
‡ 174 cases of a disease resembling small-pox; no deaths.
§ Small-pox, 1 case.
‖ Several hundred cases.

Cases of Certain Infectious Diseases and Deaths from the Same as reported to Local Boards of Health, Massachusetts, 1900 — Concluded.

City or Town.	Diphtheria and Croup.		Scarlet Fever.		Typhoid Fever.		Measles.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Wellesley,	9	1	6	-	5	-	17	-
Westborough,	25	-	7	-	11	-	3	-
Westfield,	30	9	10	1	9	7	-	-
Westford,	2	-	2	-	2	-	5	-
Weston,	3	-	1	-	6	-	4	-
West Springfield,	56	2	12	-	6	-	32	-
Whitman,	14	-	10	-	6	-	10	-
Williamstown,	6	-	2	-	22	2	5	-
Winchester,	29	2	22	-	11	-	39	-
WOBURN,	147	6	44	1	16	1	3	-
WORCESTER,	580	55	475	36	147	32	609	24
Totals,	12,528	1,274	5,963	319	2,773	458	9,954	167
Percentage,	10.2		5.3		16.5		1.7	

The summary of the foregoing figures for 1900 is as follows: —

Reported cases of diphtheria and croup,	12,528
Registered deaths from diphtheria and croup in the same cities and towns,	1,274
Fatality (per cent.),	10.2
Reported cases of scarlet fever,	5,963
Registered deaths from scarlet fever in the same cities and towns,	319
Fatality (per cent.),	5.3
Reported cases of typhoid fever,	2,773
Registered deaths from typhoid fever in the same cities and towns,	458
Fatality (per cent.),	16.5
Reported cases of measles,	9,954
Registered deaths from measles in the same cities and towns,	167
Fatality (per cent.),	1.7

The number of cities and towns contributing to this table in 1900 was 89, or the same as the number for the previous year. Most of the large cities are included, and the estimated number of their population was about 75 per cent. of the entire population of the State.

The reported cases of diphtheria and croup were 91.5 per cent. greater in number than those of 1899, and the number of deaths

about 68 per cent. greater. The fatality had again fallen from 11.6 in 1899 to 10.2 in 1900. These figures compare very favorably with the pre-antitoxin period, 1891–94, when the fatality was 28.3 per cent.

The reported cases of scarlet fever were 16.2 per cent. greater than those of the previous year, and the fatality (5.3 per cent.) was also considerably greater, but was the same as the mean fatality of the previous nine years (5.3).

The reported cases of typhoid fever were 14 per cent. in excess of those of 1899, but the fatality (16.5) was less, and was also less than the mean fatality of the nine years 1891–99, which was 18.9.

The reported cases of measles were less than those of 1899, but the fatality (1.7 per cent.) was greater than the mean fatality of the previous nine years (1.2).

The following table presents the summary of these statistics for the ten years 1891–1900: —

Reported Cases of Infectious Diseases in Massachusetts.

Diphtheria and Croup.

[Pre-Antitoxin Period.]

	1891.	1892.	1893.	1894.	Total.
Reported cases,	2,444	3,033	2,919	4,936	13,332
Deaths,	575	891	926	1,376	3,768
Fatality (per cent.),	23.5	29.2	31.7	27.9	28.3

Diphtheria and Croup.

[Antitoxin Period.]

	1895.	1896.	1897.	1898.	1899.	1900.	Total.
Reported cases,	7,856	8,915	7,856	3,843	6,540	12,528	47,538
Deaths,	1,484	1,348	1,107	507	758	1,274	6,478
Fatality (per cent.),	18.9	15.1	14.1	13.2	11.6	10.2	13.6

Scarlet Fever.

	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	Total.
Reported cases,	4,517	6,112	7,420	7,416	6,050	3,873	5,406	3,509	5,130	5,963	55,396
Deaths,	151	281	624	504	357	220	253	101	171	319	2,979
Fatality (per cent.),	3.3	4.6	8.8	6.8	5.9	5.7	4.7	2.9	3.3	5.3	5.3

Typhoid Fever.

	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	Total.
Reported cases, .	2,414	1,892	2,457	2,814	2,665	3,016	2,151	2,143	2,433	2,773	24,758
Deaths, . . .	460	435	492	488	458	471	454	464	435	458	4,610
Fatality (per cent.),	19.0	23.0	20.0	17.0	17.2	15.6	21.1	21.7	17.7	16.5	18.6

Measles.

	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	Total.
Reported cases, .	5,861	783	6,290	2,051	5,033	6,861	13,705	4,160	11,877	9,954	69,635
Deaths, . . .	84	31	98	37	75	65	96	42	119	167	814
Fatality (per cent.),	1.4	4.0	1.6	1.8	1.5	0.9	0.7	1.0	0.9	1.7	1.2

In the foregoing tables the statistics relating to diphtheria and croup have been arranged in two periods, which may properly be called the pre-antitoxin and the antitoxin periods, since antitoxin came into general use in the State about the beginning of the year 1895. The mean fatality in the former period (1891–94) was 28.3 per cent. (ratio of deaths to cases), and in the latter period (1895–1900) it was 13.6 per cent., or less than half as large.

In order to compare the general fatality from diphtheria in Massachusetts with that of another country in which systematic notification of a large number of cases has been conducted for a period of several successive years, the following figures for England are presented, as published in the annual reports of the Local Government Board: —

England.

[Local Government Board Figures.]

	Diphtheria.		Croup.		Total.		Per Cent.
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	
1890, ...	-	-	-	-	2,953	753	25.5
1891, ...	-	-	-	-	11,919	2,829	23.7
1892, ...	13,977	3,177	1,169	401	15,146	3,578	23.6
1893, ...	20,712	4,751	1,436	685	22,148	5,436	24.5
1894, ...	17,581	4,236	1,256	486	18,837	4,722	25.1
1895, ...	18,700	4,225	1,263	540	19,963	4,765	23.9
1896, ...	25,498	5,372	1,365	556	26,863	5,928	22.1
1897, ...	24,290	4,521	1,153	473	25,443	4,994	19.6
1898, ...	26,139	4,655	994	397	27,133	5,052	18.6
1899, ...	35,198	5,817	1,063	443	36,261	6,260	17.3
1900, ...	35,653	5,794	950	372	36,603	6,166	16.4
Total, ...	-	-	-	-	243,269	50,483	-
Mean fatality (per cent.), .	-		-		-		20.7

The following figures present the fatality from diphtheria and croup, scarlet fever and typhoid fever in England, as reported by the Local Government Board of England for the years 1890–1900 : —

	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.
Diphtheria and croup,	25.5	23.7	23.6	24.5	25.1	23.9	22.1	19.6	18.6	17.3	16.9
Scarlet fever, . .	8.0	5.8	4.4	4.2	4.8	4.2	4.0	3.9	3.7	3.1	3.4
Typhoid fever, . .	19.9	20.8	17.8	17.0	17.5	16.9	17.7	16.8	16.8	16.9	17.4

The Relation of the Foregoing Figures to the Type of Disease.

In accordance with the rule or formula usually attributed to Poisson, the probability of error diminishes as the number of items considered increases. In dealing with 100,000 cases of disease the possibility of arriving at a mean or average which may be considered as fairly representative of the class is much greater than it is in the case of 100, or even of 1,000 cases. In the foregoing summary the Board has accumulated, during the past ten years, the facts in regard to the fatality of 207,659 cases of four infectious diseases.

Rejecting from this number the 60,870 reported cases of diphtheria, in which the fatality appears to have been materially modified by artificial conditions, which are considered elsewhere, we still have 146,789 cases of scarlet fever, typhoid fever and measles, which may be divided into two groups occurring in two five-year periods, 1891–95 and 1896–1900. Of these, 63,675 cases were reported in the first and 82,954 cases in the second period.

While there has been a considerable range of fluctuation in the case of each disease from year to year throughout the period, when longer periods of time are considered there has been an apparent diminution in the fatality, comparing the first half of the ten years with the second.

The following figures present the fatality of each of these diseases as estimated from the reported cases and the registered deaths from each of these three diseases in the two periods : —

Fatality of Scarlet Fever, Typhoid Fever and Measles in Massachusetts in two Five-year Periods, 1891–95 and 1896–1900.

	Percentage of Deaths to Cases.			Percentage of Deaths to Cases.	
	1891-95.	1896-1900.		1891-95.	1896-1900.
Scarlet fever, . .	6.1	4.5	Measles, . . .	1.60	1.05
Typhoid fever, . .	19.1	18.2			

The following comments may be made upon the foregoing figures.

First. — The decrease in fatality is probably apparent rather than real, and may be accounted for by the fact that while the registration of deaths is probably very nearly perfect, the reporting of cases is less perfect and has probably improved (when the two periods are compared) to a sufficient degree to account for the diminution in fatality.

Secondly. — The diminution in fatality has not been so great in the case of either of these diseases as in diphtheria, wherein the fatality was reduced more than one-half when two periods, before and after the introduction of antitoxin treatment, are compared.

III.

Official Returns of Notified Diseases Dangerous to the Public Health, 1900.

The figures presented in the following summary are those of the official returns of diseases "dangerous to the public health," made to the State Board of Health during the year 1900, under the provisions of chapter 302 of the Acts of 1893. In this act no disease is specified as being "dangerous to the public health" except small-pox. Hence the State Board deemed it necessary to indicate the diseases which should be included in the meaning of the term "dangerous to the public health." They are the following: small-pox, scarlet fever, measles, typhoid fever, diphtheria, membranous croup, cholera, yellow fever, typhus fever, cerebro-spinal meningitis, hydrophobia, malignant pustule, leprosy and trichinosis.

The whole number of cases of infectious diseases reported to the Board in 1900, under the provisions of this act, was 32,600, which were divided as follows: —

Reported cases of small-pox,	104
Reported cases of diphtheria and croup,	12,641
Reported cases of scarlet fever,	6,396
Reported cases of typhoid fever,	2,967
Reported cases of measles,	10,507
Total,	32,615

The summary for the eight years 1893–1900 is as follows: —

	Reported Cases of					Total.
	Small-pox.	Diphtheria and Croup.	Scarlet Fever.	Typhoid Fever.	Measles.	
1893 (four months only),	35	1,109	2,914	1,525	1,503	7,086
1894,	181	4,178	6,731	2,372	2,133	15,595
1895,	1	7,806	6,194	2,438	4,868	21,307
1896,	5	8,515	3,801	2,637	6,362	21,320
1897,	18	7,613	5,495	2,104	12,695	27,925
1898,	10	3,980	3,667	2,196	4,478	14,331
1899,	105	7,134	5,349	2,776	12,355	27,719
1900,	104	12,641	6,396	2,967	10,507	32,615
Total,	459	52,976	40,547	19,015	54,901	167,898

Seasonal Distribution. — By months these diseases were reported as follows: —

Cases of Infectious Diseases reported to the State Board of Health by Months in 1900.

Months.	Small-pox.	Diphtheria and Croup.	Scarlet Fever.	Typhoid Fever.	Measles.	Glanders.	Months.	Small-pox.	Diphtheria and Croup.	Scarlet Fever.	Typhoid Fever.	Measles.	Glanders.
January, .	3	1,064	795	140	1,149	-	August, .	6	636	234	241	175	-
February, .	2	879	762	84	972	-	September,	1	1,053	293	560	94	-
March, .	1	882	738	125	1,407	-	October, .	5	1,605	530	600	116	-
April, .	3	656	587	80	1,500	-	November,	3	1,861	552	344	161	1
May, . .	17	743	556	119	2,113	-	December,	1	1,855	596	323	243	-
June, . .	47	809	414	164	1,800	-							
July, . .	15	546	244	150	677	2	Total, .	104	12,589	6,301	2,930	10,407	3

The difference between the total figures in the foregoing tables is accounted for by the fact that the returns of several small towns were not reported by months, but in some instances only at the close of the year, a method which is not sanctioned by the statutes, the law requiring that such reports shall be sent to the State Board "within twenty-four hours" after their receipt by the local board of health.

The significance of the foregoing figures may be more clearly understood and compared with those of the previous years by consulting the following table:—

Certain Infectious Diseases.

Intensity of Prevalence.

Months.	Diphtheria and Croup.			Scarlet Fever.			Typhoid Fever.			Measles.		
	1900.		1899.	1900.		1899.	1900.		1899.	1900.		1899.
	A	B	B	A	B	B	A	B	B	A	B	B
	Mean Daily Number of Reported Cases in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Reported Cases in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Reported Cases in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Reported Cases in Each Month.	Decimal Ratio.	Decimal Ratio.
January, .	34.3	9.9	7.2	25.6	14.8	8.1	4.5	5.6	6.2	37.1	13.0	10.2
February, .	31.4	9.1	7.4	27.2	15.7	8.6	3.0	3.7	3.4	34.7	12.2	12.7
March, .	28.5	8.3	6.1	23.8	13.8	9.7	4.0	5.0	4.4	45.4	15.9	19.5
April, .	21.9	6.3	5.4	19.6	11.3	7.0	2.7	3.4	6.0	50.0	17.5	18.1
May, . .	23.9	6.9	7.1	17.9	10.3	9.7	3.8	4.7	3.4	68.2	23.9	22.5
June, .	27.0	7.8	6.6	13.8	8.0	7.6	5.5	6.9	4.4	60.0	21.1	19.5
July, . .	17.6	5.1	8.0	7.9	4.6	5.4	4.8	6.0	6.8	21.8	7.6	6.1
August, .	20.5	5.9	7.9	7.5	4.3	5.5	7.8	9.8	16.4	5.6	2.0	0.8
September,	31.8	9.2	13.1	9.8	5.7	8.8	18.7	23.5	25.0	3.1	1.1	0.6
October, .	51.8	15.0	17.0	17.1	9.9	14.2	19.4	24.9	19.1	3.7	1.3	1.2
November,	62.0	18.0	15.9	18.4	10.6	16.5	11.5	14.4	13.5	5.4	1.9	2.3
December,	59.8	17.3	18.4	19.2	11.1	19.0	10.4	13.0	11.0	7.8	2.7	6.5
Mean, .	34.5	10.0	10.0	17.3	10.0	10.0	8.0	10.0	10.0	28.5	10.0	10.0

The object of the foregoing table is to present the figures for each month upon a uniform basis of comparison, month by month, so that the relative intensity of prevalence of each disease is shown for each month. The method also has the advantage of eliminating the apparent errors of computation arising from the unequal length of the months.

The figures may be read as follows: For example, the mean daily number of reported cases of diphtheria and croup in January, 1900, was 34.3; of scarlet fever, 25.6; of typhoid fever, 4.5; and of measles, 37.1 (see columns marked A); and the mean daily number of reported cases of the same diseases for the whole year 1900 was, respectively, 34.5, 17.3, 8.0 and 28.5. Assuming a standard of 10 as a daily mean of each disease for the year, the ratios for January were as follows: diphtheria and croup, 9.9; scarlet fever, 14.8; typhoid fever, 5.6; and measles, 13.0. (See columns marked B.) That is to say, for each 10 cases of diphtheria and croup reported daily throughout the year 1900, as a mean, there were 9.9 in January, 9.1 in February, 8.3 in March, etc.

It appears from the foregoing table that the seasonal prevalence of diphtheria and croup in the year 1900 showed a gradual decrease until it reached its minimum in July, and then rose more rapidly to a maximum in November. In 1899 it reached its maximum in December. In the first nine months of 1900 the prevalence was below the mean, and above it in the last three months.

Scarlet fever was at its maximum prevalence in February, decreasing to a minimum in August. Its prevalence was above the mean of the year in the first five months, below it in the next five months, and again above it in November and December.

Typhoid fever was below the mean in the intensity of its prevalence throughout the first eight months of 1900, rising rapidly to a maximum in October of nearly two and one-half times its mean prevalence.

Measles also prevailed with an intensity greater than the mean in the first half of the year, having an intensity more than twice as great as the mean in May, and falling to about one-tenth of the mean in September. It also remained with a low intensity throughout the remainder of the year. The whole number of reported cases was less by 1,848 than those of 1899, but more than twice as many as those reported in 1898.

The following table presents the number of cases of infectious diseases reported to the Board from each city and town in 1900. Not

only was the number of reported cases materially increased when the returns of the two previous years are considered, but the number of reporting cities and towns was also largely increased. The reporting cities and towns in 1898 were only 167; in 1899 they were 219, and in 1900 the number had increased to 262.

These waves of recrudescence are of common occurrence everywhere, and may be partly accounted for by the constant accessions of young children who have not been protected by an attack of one of the infectious diseases which usually confer immunity by the first attack. In those diseases, like typhoid fever, which for the most part occur later in life, the number of reported cases in each year is much more uniform.

Cases of Infectious Diseases reported to the State Board of Health from Two Hundred and Sixty-three Cities and Towns during 1900.

	Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.		Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.
Abington, . .	5	7	2	4	Berkley, . . .	1	-	-	-
Acton, . . .	20	3	-	-	Berlin, . . .	-	2	-	1
Acushnet, . .	-	1	-	10	BEVERLY, . .	19	37	40	75
Adams, . . .	19	4	-	-	Billerica, . . .	-	6	4	13
Agawam, . . .	2	-	-	-	Blackstone, . .	-	-	19	-
Amesbury, . .	7	24	22	206	Blandford, . .	-	-	1	-
Amherst, . . .	-	28	-	30	Bolton, . . .	-	-	1	4
Andover, . . .	48	33	9	1	BOSTON, . . .	4,967	1,709	726	2,756
Arlington, . .	51	26	9	58	Boxford, . . .	1	-	-	-
Ashland, . . .	10	4	1	-	Boylston, . . .	1	-	6	-
Athol, . . .	6	6	3	2	Braintree, . .	17	7	3	4
Attleborough, . .	24	8	5	19	Brewster, . .	-	3	1	3
Auburn, . . .	1	1	-	-	Bridgewater, . .	16	-	-	-
Avon, . . .	2	1	3	1	Brimfield, . .	-	4	-	59
Ayer, . . .	9	3	1	-	BROCKTON, . .	119	19	57	268
Barnstable, . .	2	-	1	5	Brookfield, . .	-	7	24	1
Barre, . . .	-	16	1	110	Brookline, . .	235	28	16	68
Becket, . . .	4	-	-	-	Buckland, . .	1	-	-	-
Bedford, . . .	2	-	4	4	Burlington, . .	3	-	-	-
Belchertown, . .	-	-	-	46	CAMBRIDGE, . .	892	170	98	138
Bellingham, . .	1	4	3	6	Canton, . . .	2	-	-	2
Belmont, . . .	14	3	3	7	Carver, . . .	8	-	-	-

Cases of Infectious Diseases reported to the State Board of Health from Two Hundred and Sixty-three Cities and Towns during 1900 — Continued.

	Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.		Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.
Charlton,	-	22	3	-	Framingham,	14	5	5	2
Chelmsford,	1	1	1	2	Franklin,	2	43	32	-
CHELSEA,	216	43	17	107	Gardner,	27	13	6	-
Chester,	-	2	1	-	Georgetown,	2	10	1	37
CHICOPEE,	18	21	30	119	Gill,	-	-	-	33
Clinton,	33	17	4	144	GLOUCESTER,	90	60	3	7
Cohasset,	1	4	1	1	Grafton,	3	7	-	-
Colrain,	5	10	-	-	Granby,	3	-	-	-
Concord,	18	12	3	3	Granville,	1	5	1	8
Conway,	1	-	-	-	Great Barrington,	4	16	-	-
Cottage City,	-	-	1	-	Greenfield,	8	29	14	4
Dalton,	4	12	-	-	Groton,	1	-	1	1
Danvers,	43	8	6	-	Groveland,	2	18	3	5
Dartmouth,	7	6	-	-	Hadley,	2	18	3	-
Dedham,	12	6	1	4	Hamilton,	-	1	-	-
Deerfield,	-	7	-	-	Hampden,	1	-	-	3
Dennis,	-	1	-	-	Hardwick,	2	17	2	2
Dighton,	7	10	-	-	Harvard,	-	1	-	-
Douglas,	-	5	2	1	Harwich,	3	3	-	-
Dracut,	-	1	-	-	Hatfield,	-	9	-	1
Dudley,	-	1	1	-	HAVERHILL,	87	122	112	36
Dunstable,	-	-	-	3	Hingham,	-	11	-	-
Duxbury,	3	1	2	20	Hinsdale,	2	14	-	-
Easthampton,	3	4	2	5	Holbrook,	1	-	-	-
East Longmeadow,	8	2	-	12	Holden,	-	3	4	-
Edgartown,	-	-	1	6	Holliston,	-	22	4	2
Egremont,	1	3	-	-	HOLYOKE,	274	173	30	350
Essex,	2	-	1	-	Hopedale,	5	15	8	-
EVERETT,	217	52	29	102	Hubbardston,	-	5	1	-
Fairhaven,	1	12	19	8	Hudson,	11	4	2	198
FALL RIVER,	76	41	64	2	Hull,	2	-	1	2
Falmouth,	4	1	-	2	Huntington,	-	4	1	-
FITCHBURG,	103	87	54	118	Hyde Park,	8	14	5	5
Foxborough,	5	4	11	2	Ipswich,	6	3	16	2

Cases of Infectious Diseases reported to the State Board of Health from Two Hundred and Sixty-three Cities and Towns during 1900 — Continued.

	Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.		Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.
Kingston,	-	-	-	12	Montague,	4	18	3	-
Lancaster,	3	-	1	31	Nantucket,	1	-	1	-
LAWRENCE,	215	95	77	290	Natick,	8	1	4	-
Lee,	-	14	-	-	Needham,	3	3	2	13
Leicester,	1	2	-	7	NEW BEDFORD,	34	360	125	358
Lenox,	-	2	1	-	Newbury,	-	7	8	-
Leominster,	39	30	2	32	NEWBURYPORT,	17	8	44	31
Leverett,	1	1	-	-	New Marlborough,	-	1	-	-
Lexington,	4	17	3	8	NEWTON,	349	111	42	356
Lincoln,	7	-	1	-	Norfolk,	2	-	-	-
Littleton,	2	10	5	-	NORTH ADAMS,	17	31	62	20
LOWELL,	154	85	84	119	NORTHAMPTON,	30	55	40	42
Ludlow,	18	2	10	-	North Andover,	14	6	7	12
Lunenburg,	-	1	1	-	North Attleborough,	11	5	1	4
LYNN,	415	127	46	233	Northborough,	2	14	9	109
MALDEN,	137	163	53	454	Northbridge,	1	23	4	1
Manchester,	5	25	-	-	North Brookfield,	22	37	2	-
Mansfield,	-	4	1	-	Northfield,	-	-	-	8
Marblehead,	33	9	8	8	Norton,	-	1	2	1
Marion,	2	-	3	1	Norwell,	1	-	1	-
MARLBOROUGH,	19	20	10	509	Norwood,	18	5	47	4
Maynard,	5	2	-	-	Oakham,	-	5	2	12
Medfield,	6	2	-	62	Orange,	-	1	-	-
MEDFORD,	69	149	22	141	Orleans,	3	-	-	-
Medway,	-	20	-	6	Otis,	-	1	-	-
MELROSE,	34	39	14	109	Oxford,	4	-	-	1
Mendon,	-	5	1	-	Palmer,	55	13	7	40
Merrimac,	-	9	-	-	Paxton,	-	-	-	11
Middleborough,	12	8	1	3	Peabody,	23	10	4	-
Milford,	38	52	6	2	Pelham,	-	1	-	-
Millbury,	5	26	2	56	Pepperell,	-	-	1	2
Millis,	1	1	-	-	Petersham,	-	1	1	-
Milton,	22	20	13	52	PITTSFIELD,	35	97	9	204
Monson,	8	6	-	7	Plymouth,	1	11	4	31

Cases of Infectious Diseases reported to the State Board of Health from Two Hundred and Sixty-three Cities and Towns during 1900 — Continued.

	Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.		Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.
Princeton,	1	3	–	6	Sudbury,	2	1	1	4
QUINCY,	230	38	46	25	Sutton,	2	8	–	1
Randolph,	8	4	5	5	Swampscott,	15	8	1	2
Reading,	5	33	9	20	Swansea,	2	–	–	–
Revere,	69	10	–	1	TAUNTON,	27	25	15	55
Rochester,	1	–	–	–	Templeton,	10	16	–	–
Rockland,	–	2	5	7	Topsfield,	–	–	1	–
Rockport,	2	6	6	–	Townsend,	1	–	2	17
Rowley,	1	–	1	–	Truro,	–	1	–	–
Royalston,	4	5	1	1	Tyringham,	1	–	–	–
SALEM,	199	81	41	342	Upton,	–	10	1	1
Salisbury,	1	–	5	–	Uxbridge,	–	13	6	15
Sandisfield,	–	2	–	23	Wakefield,	50	44	1	20
Saugus,	7	6	1	–	Walpole,	1	–	7	1
Scituate,	–	2	–	6	WALTHAM,	431	50	28	15
Sharon,	1	–	2	6	Ware,	–	8	4	1
Sheffield,	1	6	–	–	Wareham,	13	–	–	10
Shelburne,	–	2	–	–	Warren,	5	17	4	37
Sherborn,	1	–	1	28	Watertown,	74	19	17	15
Shirley,	2	11	–	3	Wayland,	1	–	–	–
Shrewsbury,	1	–	2	–	Webster,	2	8	16	–
Somerset,	1	8	–	–	Wellesley,	8	7	5	22
SOMERVILLE,	506	225	73	151	Wenham,	–	2	–	–
Southampton,	2	–	1	3	Westborough,	20	6	16	1
Southborough,	2	–	1	19	West Boylston,	1	1	–	–
Southbridge,	4	3	–	–	West Bridgewater,	1	–	–	–
South Hadley,	25	8	1	63	West Brookfield,	–	–	1	–
Spencer,	3	–	–	2	Westfield,	14	7	3	2
SPRINGFIELD,	224	102	68	171	Westford,	–	2	–	3
Sterling,	1	1	4	3	Westhampton,	–	4	–	–
Stockbridge,	8	33	2	4	Westminster,	–	11	–	16
Stoneham,	20	17	3	1	West Newbury,	3	–	–	–
Stoughton,	10	3	2	1	Weston,	8	1	–	3
Sturbridge,	2	2	–	8	Westport,	2	–	–	11

Cases of Infectious Diseases reported to the State Board of Health from Two Hundred and Sixty-three Cities and Towns during 1900 — Concluded.

	Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.		Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.
West Springfield,	57	6	11	30	Winchendon,	10	31	5	44
Westwood,	-	2	-	-	Winchester,	28	16	9	52
Weymouth,	29	4	4	8	Winthrop,	24	15	3	4
Whitman,	16	9	4	9	WOBURN,	97	31	14	2
Wilbraham,	7	5	-	3	WORCESTER,	554	406	110	530
Williamsburg,	1	1	-	3	Wrentham,	2	6	-	-
Williamstown,	3	2	29	4	Yarmouth,	7	-	-	3
Wilmington,	1	3	-	2	Totals,	12,641	6,396	2,967	10,507

Small-pox occurred in the following cities and towns: —

Acushnet,	2
BOSTON,	6
CHICOPEE,	5
FALL RIVER,	37
Gardner,	1
LAWRENCE,	1
LOWELL,	23
MALDEN,	2
Middleborough,	3
Oxford,	2
TAUNTON,	1
Watertown,	1
Westport,	19
WORCESTER,	1
Total,	104

Glanders occurred in the following cities: —

FITCHBURG,	2
FRAMINGHAM,	1
Total,	3

To the foregoing cases should also be added the 174 cases which were reported from New Bedford, under the name of "a contagious eruptive disease."

List of Towns from which no Reports were received.

I. Town having a Population of More than 5,000.

Methuen.

II. Towns having a Population of More than 1,000 but Less than 5,000 in Each.

Ashburnham,	East Bridgewater,	Mattapoisett,
Bourne,	Easton,	Raynham,
Chatham,	Hanover,	Rehoboth,
Cheshire,	Hopkinton,	Tewksbury. — 14.
Clarksburg,	Marshfield,	

III. Towns having Less than 1,000 Inhabitants.

Alford,	Holland,	Prescott,
Ashby,	Lakeville,	Richmond,
Bernardston,	Lanesborough,	Rowe,
Boxborough,	Leyden,	Russell,
Carlisle,	Longmeadow,	Rutland,
Chesterfield,	Lynnfield,	Savoy,
Chilmark,	Mashpee,	Shutesbury,
Cummington,	Middlefield,	Southwick,
Dana,	Middleton,	Stow,
Dover,	Monroe,	Sunderland,
Eastham,	Monterey,	Tolland,
Enfield,	Montgomery,	Tyngsborough,
Erving,	Mount Washington,	Wales,
Florida,	Nahant,	Warwick,
Gay Head,	New Ashford,	Washington,
Goshen,	New Braintree,	Wellfleet,
Gosnold,	New Salem,	Wendell,
Greenwich,	North Reading,	West Stockbridge,
Halifax,	Peru,	West Tisbury,
Hancock,	Phillipston,	Whately,
Hawley,	Plainfield,	Windsor,
Heath,	Plympton,	Worthington. — 66.

The following towns sent notices to the Board that no infectious diseases had been reported within their limits during the year 1900: —

Ashfield,	Hanson,	Sandwich,
Charlemont,	Pembroke,	Seekonk,
Freetown,	Provincetown,	Tisbury.

A supply of postal cards for the purpose of reporting infectious diseases to the State Board of Health, as required by statute, will be forwarded to any local board of health on application to the Secretary of the State Board, Room 141, State House, Boston.

IV.

Official Returns of Deaths in Cities and Large Towns (Chapter 218, Acts of 1894).

The following summary comprises the results obtained from the tabulation of the returns required by chapter 218 of the Acts of 1894, whereby the board of health of each city and populous town is directed to send to the State Board of Health an annual statement of the deaths in such city or town upon a blank form furnished by the State Board.

The whole number of cities and towns included in this list is 94.* The total population of these 94 cities and towns by the census of 1900 was 2,364,773, or 84.3 per cent. of the total population. The total gain in the reporting population over that of 1899 was 330,115.

The taking of the United States census of 1900 has added five towns to the list of places having a population of more than 5,000 in each during the five years which have elapsed since the taking of the State census of 1895, viz., Amherst, Great Barrington, Norwood, Wellesley and Winchendon. Pittsfield and Northbridge, which did not report in 1899, have each joined the list of reporting cities and towns, so that every city is now included in the list.

On the other hand, two towns, Millbury and Rockport, each of which had more than 5,000 inhabitants in 1895, had so far diminished as to fall below 5,000 in their populations in 1900, Millbury dropping from 5,222 to 4,460 and Rockport from 5,289 to 4,592.

The net gain by addition of new towns to the list and by the reporting of two which had not hitherto reported was 46,185.

The whole number of deaths registered in these towns in 1900 was 43,192, and the death-rate as calculated from the census population of the reporting cities and towns was 18.26 per 1,000 of the living population, that of the preceding year having been 17.26 per 1,000. The mean death-rate of the State for the fifty years ended Dec. 31, 1900, was 19.22.

Sexes. — The number of deaths of males was 21,669, or 50.1 per cent. of the whole number of those whose sex was known; and the

* The town of Montague failed to make the necessary return for 1900.

deaths of females were 21,509, or 49.9 per cent. There were 14 in which the sex was not stated in the returns.

Ages. — The deaths by four groups of ages were as follows : —

Ages.	Deaths. 1900.	Percentages of all Deaths. 1900.	1899.	Ages.	Deaths. 1900.	Percentages of all Deaths. 1900.	1899.
Under 1 year,	9,935	23.02	22.84	20 to 50,	10,436	24.18	25.09
1 to 20 years,	7,335	17.00	15.94	50 and over,	15,449	35.80	36.13

The deaths of infants under one year old were 9,935, or 23 per cent. of the total mortality, as compared with 22.8 per cent. in the previous year, and those of children under five years old were 14,375, or 33.3 per cent. of the total mortality, as compared with 31.9 per cent. in 1899.

All of the percentages in this table are estimated upon the number of deaths of those whose ages were specified in the returns. The total number of deaths in which the age was not specified was 37.

The infant mortality for the five years 1896–1900 respectively constituted 24.9, 23.5, 24.8, 22.8 and 23 per cent. of the total mortality.

Still-births. — The number of still-births was 2,733.

The still-birth mortality when compared with the total mortality (still-births included) was 5.9 per cent of the total deaths and still-births combined. That of Boston was 4.7 per cent., while that of other places varied, Fall River* having an excessive mortality from still-births, or 14.9 per cent. of the combined mortality (total deaths and still-births taken together).

Months and Quarters. — The number of deaths in each quarter of the year is shown in the following table : —

	Deaths. 1900.	Percentages. 1900.	1899.
First quarter,	11,478	26.58	26.97
Second quarter,	10,386	24.05	23.25
Third quarter,	11,847	27.43	26.50
Fourth quarter,	9,478	21.94	23.28
Total,†	43,189	100.00	100.00

* The excessive number of the still-born in Fall River may be partly accounted for by its very high birth-rate, which for several years has exceeded 40 per 1,000.

† There were three deaths, the date of which was unknown, and they are not included in this total.

These percentages differ but slightly from the mean of several years, which shows the highest mortality in the third quarter of the year. In 1899 the highest mortality was in the first quarter.

The intensity of the seasonal death-rate is more accurately shown in the following table, the method employed being explained on page 774 in Section III. of these summaries, relating to disease notification. By this method the errors which are due to differences in the length of the months are eliminated.

	Deaths in Each Month.	Mean Daily Deaths per Month. 1900.	Centesimal Ratio.	
			1900.	1899.
January,	3,511	113.3	95.8	123.0
February,	3,236	115.5	97.6	111.1
March,	4,731	152.6	129.0	94.3
April,	4,058	135.3	114.4	101.8
May,	3,367	108.6	91.8	90.6
June,	2,961	98.7	83.4	87.1
July,	3,993	128.8	108.9	107.9
August,	4,264	137.5	116.2	109.7
September,	3,590	119.7	101.2	97.6
October,	3,197	103.1	87.2	86.5
November,	3,024	100.8	85.2	88.8
December,	3,257	105.1	88.8	101.8
Annual mean,	. .	118.3	100.0	100.0

The figures in the foregoing table indicate a departure in excess of the mean death-rate, in March, April, July, August and September, while that of the remaining months was low.

The mean maximum departure from the death-rate for each month for the period of twenty years, 1856–75, was 32.9 per cent. in August, and in the twenty-year period 1876–95 it was 20 per cent. in August, while that of August, 1900, was only 16.2 per cent., and that of March, 1900, was 29 per cent.

In the two years having the highest death-rates in Massachusetts in the past half century (1849 and 1872) the maximum departures from the yearly means were, respectively, 83.4 per cent. in August, 1849, and 40 per cent. in August, 1872. That of January, 1890, the month in which the epidemic of influenza was at its maximum, was 43.4 per cent. above the mean.

Causes of Death.

Table III. presents the mortality of the cities and towns embraced in this summary, classified by causes of death for the year 1900. The same figures are again presented in a condensed form in Table IV., wherein the comparative mortality from different diseases and groups of diseases for the past five years may be examined.

An examination of Table IV. on page 796 shows that the general death-rate in these reporting cities and towns had risen again in 1900, but the increase had not raised the death-rate to the average of a long series of years. This rise in the general death-rate appears to be chiefly due to the increase in the mortality from infectious diseases. Out of eight principal infectious diseases named in the last report (consumption, measles, scarlet fever, diphtheria, whooping-cough, typhoid fever, puerperal fever and cholera infantum), the death-rate from each of these causes had increased, except that of typhoid fever, in which there was a slight decrease.

The combined death-rate per 10,000 of the population from these eight causes for the six years (1895–1900) in the cities and towns included in this report (about five-sixths of the total population of the State) was as follows: —

Combined Death-rate from Eight Principal Infectious Diseases.

Year.	Combined Death-rate per 10,000.	Year.	Combined Death-rate per 10,000.
1895,	46.4	1898,	36.3
1896,	46.8	1899,	35.2
1897,	39.7	1900,	40.7

Table III., which has appeared in the successive reports of the past six years, presenting the deaths by months for each city and town and for the whole State, is omitted in the present report, since the details presented in this table are not of essential value. Its chief value consisted in the column of total figures for the State, which is retained essentially in the table on page 783.

The table of percentages of total mortality shown in Table IV. acts, in a measure, as a check or control in case of erroneous estimates of population, and while such errors are not to be found in the figures

of a census year, it seems best as a matter of uniformity to publish the table in the same form as in previous intercensal years.

The changes in the death-rate from consumption, typhoid fever and puerperal fever (see child-birth in report of 1896, page 804) have been quite fully treated in the report of 1896. To these may be added the later comments on the changes in the death-rate from diphtheria, which appear in the figures of the past five years.

The following preventable causes of death, consumption, measles, scarlet fever, diphtheria, whooping-cough, typhoid fever, puerperal fever and cholera infantum, together constituted 27.2 per cent. of the total mortality in 1894, but had fallen off to 24.2, 24.2, 21.9, 21.1, 20.4 and 22.3 in the six succeeding years, while the principal acute lung diseases, diseases of the heart, brain, kidneys, cancer, suicide and accident had increased from 35.7 per cent. of the total mortality to 36.9, 36.9, 38.5, 39.2, 40.2 and 38.6 per cent. in the same years.

This increase of 1.9 per cent. in the former group is nearly balanced by a decrease of 1.6 in the latter group.

These all combined constituted the greater part of the total mortality in each of the seven years 1894–1900, and of the diseases specified in the table entitled the "Balance of Mortality," in the annual report of 1896, page 812.

The most notable changes in the figures of Table IV. are the slight rise in the death-rate from consumption, as compared with that of 1899. The death-rates from scarlet fever and measles were greater than they were in any of the previous five years, while that of diphtheria was greater than that of any year since 1896. (This death-rate, however, should not be confounded with the fatality of diphtheria—ratio of deaths to cases—which has steadily fallen since 1894 and is now less than half as great as it then was.) The death-rate from whooping-cough was greater than that of 1899, but less than that of 1898. The death-rate from typhoid fever was less than it has ever been since the beginning of registration. The death-rate from cholera infantum was greater than those of 1899 and 1897, but less than those of 1898 and 1896.

TABLE I.

Population of Cities and Large Towns. (Census of 1900.)

Reporting Cities and Towns.	Population for 1900.	Reporting Cities and Towns.	Population for 1900.
Adams,	11,134	Hudson,	5,454
Amesbury,	9,473	Hyde Park,	13,244
Amherst,	5,028	LAWRENCE,	62,559
Andover,	6,813	Leominster,	12,392
Arlington,	8,603	LOWELL,	94,969
Athol,	7,061	LYNN,	68,513
Attleborough,	11,335	MALDEN,	33,664
BEVERLY,	13,884	Marblehead,	7,582
Blackstone,	5,721	MARLBOROUGH,	13,609
BOSTON,	560,892	MEDFORD,	18,244
Braintree,	5,981	MELROSE,	12,962
Bridgewater,	5,806	Methuen,	7,512
BROCKTON,	40,063	Middleborough,	6,885
Brookline,	19,935	Milford,	11,376
CAMBRIDGE,	91,886	Milton,	6,578
CHELSEA,	34,072	Natick,	9,488
CHICOPEE,	19,167	NEW BEDFORD,	62,442
Clinton,	13,667	NEWBURYPORT,	14,478
Concord,	5,652	NEWTON,	33,587
Danvers,	8,542	NORTH ADAMS,	24,200
Dedham,	7,457	NORTHAMPTON,	18,643
Easthampton,	5,603	North Attleborough,	7,253
EVERETT,	24,336	Northbridge,	7,036
FALL RIVER,	104,863	North Brookfield,	4,587
FITCHBURG,	31,531	Norwood,	5,480
Framingham,	11,302	Orange,	5,520
Franklin,	5,017	Palmer,	7,801
Gardner,	10,813	Peabody,	11,523
GLOUCESTER,	26,121	PITTSFIELD,	21,766
Grafton,	4,869	Plymouth,	9,592
Great Barrington,	5,854	QUINCY,	23,899
Greenfield,	7,927	Reading,	4,969
HAVERHILL,	37,175	Revere,	10,395
Hingham,	5,059	Rockland,	5,327
HOLYOKE,	45,712	SALEM,	35,956

TABLE I. — *Concluded.*

Reporting Cities and Towns.	Population for 1900.	Reporting Cities and Towns.	Population for 1900.
SOMERVILLE,	61,643	Westborough,	5,400
Southbridge,	10,025	Westfield,	12,310
Spencer,	7,627	West Springfield,	7,105
SPRINGFIELD,	62,059	Weymouth,	11,324
Stoneham,	6,197	Whitman,	6,155
Stoughton,	5,442	Williamstown,	5,013
TAUNTON,	31,036	Winchendon,	5,001
Wakefield,	9,290	Winchester,	7,248
WALTHAM,	23,481	Winthrop,	6,058
Ware,	8,263	WOBURN,	14,254
Watertown,	9,706	WORCESTER,	118,421
Webster,	8,804	Total,	2,364,773
Wellesley,	5,072		

TABLE II.

Total Deaths, Deaths by Sexes and Age Periods, and Still-births in Cities and Towns having over 5,000 Inhabitants in Each, with General Death-rates estimated for 1900.

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Adams, ...	182	85	95	2	14	68	14	6	3	3	1	1	6	22	6	9	11	18	10	4	-	16.35
Amesbury, ...	147	63	83	1	10	21	7	3	-	2	6	1	4	9	8	16	15	19	21	15	-	15.52
Amherst, ...	98	56	42	-	4	8	1	1	-	-	1	4	6	5	8	5	7	17	18	17	-	19.48
Andover, ...	91	39	52	-	2	11	3	2	-	1	1	-	2	4	6	5	8	21	14	13	-	13.36
Arlington, ...	145	63	82	-	4	23	8	6	2	3	4	5	4	7	11	12	8	16	21	15	-	16.86
Athol, ...	98	44	53	1	6	19	3	2	1	1	4	-	4	8	8	10	6	9	14	9	-	13.88
Attleborough, ...	186	96	90	-	9	43	8	5	3	1	6	6	4	11	18	17	11	21	19	12	1	16.49
BEVERLY, ...	207	107	100	-	13	33	3	3	2	1	3	2	7	20	13	19	19	24	37	21	-	15.27
Blackstone, ...	124	59	65	-	4	28	7	3	3	4	3	2	3	12	9	3	15	8	18	6	-	21.67
BOSTON, ...	11,678	5,980	5,698	-	573	2,410	604	331	235	172	355	127	260	1,107	1,198	1,054	1,174	1,198	912	541	-	20.82
Braintree, ...	98	50	48	-	6	20	2	2	1	1	2	3	1	9	6	9	8	9	18	7	-	16.39
Bridgewater, ...	76	32	44	-	2	10	-	-	-	-	2	2	2	4	2	7	5	16	17	9	-	13.08
BROCKTON, ...	553	281	272	-	37	109	24	11	9	7	15	11	18	48	50	56	40	70	53	32	-	13.80
Brookline, ...	272	130	142	-	13	35	7	6	5	2	7	2	6	20	18	22	33	41	47	21	-	13.64
CAMBRIDGE, ...	1,547	782	765	-	123	356	77	26	31	21	52	32	38	141	121	130	144	153	135	90	-	16.84
CHELSEA, ...	651	384	267	-	41	132	38	12	14	13	14	12	22	42	41	45	53	93	82	38	-	19.10
CHICOPEE, ...	398	195	203	-	22	158	36	7	8	4	7	5	2	37	27	20	20	30	22	15	-	20.76
Clinton, ...	203	105	98	-	19	56	16	3	-	3	7	4	7	20	14	18	15	16	16	8	-	14.85
Concord, ...	56	28	28	-	2	3	2	-	1	1	2	1	4	9	5	6	5	5	8	4	-	9.91
Danvers, ...	108	41	67	-	-	17	1	3	-	-	2	2	3	9	5	4	9	11	26	16	-	12.65
Dedham, ...	94	50	44	-	-	15	2	-	2	-	1	1	3	7	7	7	10	13	12	14	-	12.60
Easthampton, ...	98	46	52	-	2	17	4	1	2	4	-	4	-	8	2	4	10	18	12	10	2	17.50

EVERETT,	367	169	198	-	24	101	14	11	8	6	11	3	7	42	24	26	32	42	26	12	2	15.08
FALL RIVER,	2,206	1,078	1,128	-	386	810	*-	*-	*-	*-	87	40	51	155	154	129	181	156	78	38	-	21.04
FITCHBURG,	471	257	214	-	50	133	30	11	7	6	10	8	13	26	39	41	38	44	31	34	-	14.94
Framingham,	202	84	118	-	8	30	3	1	-	1	3	6	9	22	23	12	16	25	28	21	2	17.88
Franklin,	109	60	48	1	3	14	4	2	1	2	6	1	4	4	8	8	11	14	16	14	-	21.71
Gardner,	236	111	123	2	9	56	11	6	8	4	6	8	5	20	19	12	23	18	23	15	2	21.83
GLOUCESTER,	381	204	177	-	36	66	11	10	6	3	10	†-	†-	28	24	35	33	46	51	45	-	14.58
Grafton,	90	49	41	-	5	17	3	-	1	1	1	-	2	6	5	9	10	13	13	8	1	18.48
Great Barrington,	79	41	38	-	2	11	1	2	1	-	2	2	3	5	5	8	6	14	10	9	-	13.50
Greenfield,	111	51	60	-	12	17	2	1	1	3	2	1	2	17	6	6	11	16	15	11	-	14.00
HAVERHILL,	565	274	291	-	60	92	16	6	3	8	17	8	11	47	52	60	57	78	63	47	-	15.19
Hingham,	91	51	40	-	1	16	2	-	1	1	3	-	-	5	6	6	2	14	21	14	-	17.98
HOLYOKE,	984	482	502	-	79	294	80	41	27	21	37	13	23	73	62	65	81	87	57	22	1	21.53
Hudson,	82	44	38	-	3	21	3	2	3	-	3	-	3	2	4	4	6	10	12	9	-	15.05
Hyde Park,	200	98	102	-	11	42	12	1	1	1	4	1	7	12	14	12	22	31	27	13	-	15.10
LAWRENCE,	1,250	658	592	-	100	394	81	27	16	15	32	19	33	90	104	104	108	118	72	32	5	19.98
Leominster,	180	72	108	-	23	42	8	3	4	1	10	4	5	11	14	9	12	20	23	14	-	14.52
LOWELL,	1,849	947	902	-	117	523	96	35	24	9	47	17	44	153	172	159	171	177	139	83	-	19.47
LYNN,	1,086	531	555	-	64	228	28	26	19	5	28	17	31	92	85	97	97	144	115	73	1	15.85
MALDEN,	493	230	263	-	32	121	23	8	6	7	12	2	13	40	35	31	43	65	44	43	-	14.64
Marblehead,	150	73	77	-	3	14	3	1	1	-	5	2	3	10	8	13	15	17	33	25	-	19.89
MARLBOROUGH,	206	96	110	-	9	58	17	4	3	1	4	4	7	14	13	10	15	23	19	12	2	15.14
MEDFORD,	244	110	134	-	12	56	6	5	4	1	4	5	2	10	14	16	21	27	45	28	-	13.37
MELROSE,	211	103	108	-	3	40	6	2	2	1	1	11	4	17	13	15	18	32	31	18	-	16.28
Methuen,	138	64	74	-	9	25	6	3	4	1	4	1	3	7	9	7	7	30	17	14	-	18.28
Middleborough,	137	62	75	-	1	18	3	1	1	-	5	-	2	5	10	14	9	19	26	24	-	19.88
Milford,	205	103	102	-	3	29	7	2	5	1	5	3	3	25	13	8	29	27	33	15	-	18.01
Milton,	95	47	48	-	8	6	5	3	-	1	5	3	2	4	8	14	9	12	13	10	-	14.44
Natick,	123	58	65	-	7	10	1	2	2	-	2	2	1	6	12	17	18	15	24	11	-	12.96
NEW BEDFORD,	1,285	646	639	-	99	424	78	30	15	14	26	23	37	78	69	87	88	117	112	87	-	20.58
NEWBURYPORT,	301	140	161	-	23	37	10	4	3	4	4	6	10	22	21	21	23	38	61	37	-	20.77

* Three hundred and twenty-seven from one to five years.

† Thirteen from ten to twenty years.

TABLE II. — *Concluded.*

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
NEWTON,	502	264	238	-	24	108	23	11	7	7	18	10	9	34	34	27	43	62	59	49	1	14.94
NORTH ADAMS,	345	169	176	-	24	93	17	9	4	3	11	3	10	30	24	19	35	38	30	19	-	14.25
NORTHAMPTON,	370	191	179	-	11	77	9	4	4	5	6	2	11	28	20	27	39	36	61	41	-	19.84
North Attleborough,	106	62	44	-	8	14	4	-	3	2	2	-	2	5	11	7	13	16	17	9	1	14.62
Northbridge,	157	84	73	-	15	51	8	5	1	1	3	2	6	14	15	13	9	9	12	8	-	22.30
North Brookfield,	79	46	33	-	6	14	2	-	3	-	2	1	2	7	9	7	2	13	12	3	2	17.21
Norwood,	78	37	40	1	5	23	3	2	1	1	1	4	1	5	7	6	6	8	8	2	-	14.23
Orange,	87	40	47	-	5	16	3	-	1	1	2	2	2	5	10	4	7	7	14	12	1	15.76
Palmer,	177	101	76	-	12	67	7	4	8	2	10	2	3	11	11	13	5	14	15	4	1	22.69
Peabody,	217	105	112	-	8	44	6	-	-	1	4	1	7	18	20	12	26	29	27	22	-	18.83
PITTSFIELD,	426	220	204	2	19	79	8	7	5	6	12	6	10	35	45	41	36	46	54	36	-	19.56
Plymouth,	184	80	104	-	8	25	5	1	1	-	6	3	4	15	15	14	16	22	32	24	1	19.18
QUINCY,	345	168	177	-	25	76	15	9	9	8	21	10	8	16	19	19	22	42	45	24	2	14.43
Reading,	95	40	55	-	4	14	2	-	-	-	4	-	2	7	6	6	8	15	11	18	2	19.11
Revere,	140	66	74	-	8	29	8	8	5	4	3	3	4	12	9	12	14	14	11	4	-	13.46
Rockland,	90	43	47	-	4	7	4	1	-	1	1	1	2	13	7	9	8	10	16	10	-	16.88
SALEM,	704	332	372	-	34	187	37	15	15	11	20	5	13	38	51	41	74	68	74	55	-	19.58
SOMERVILLE,	967	472	495	-	41	226	44	21	14	13	35	21	20	72	64	58	91	108	102	78	-	15.69
Southbridge,	219	98	121	-	24	59	14	8	4	4	10	2	7	16	9	14	16	18	23	15	-	21.83
Spencer,	115	57	58	-	8	17	6	3	2	2	1	2	4	14	12	9	10	10	10	13	-	15.07
SPRINGFIELD,	1,143	543	600	-	49	257	55	25	13	14	31	18	31	82	83	81	113	141	126	73	-	18.41
Stoneham,	92	44	48	-	2	8	1	1	1	-	2	1	2	3	9	8	13	15	15	13	-	14.84
Stoughton,	119	64	55	-	1	27	6	1	1	1	1	-	1	11	13	8	8	9	13	19	-	21.87
TAUNTON,	656	353	303	-	30	157	27	6	10	4	12	8	14	49	51	42	64	82	84	46	-	21.13
Wakefield,	119	57	62	-	5	5	4	1	-	1	6	5	3	8	9	12	10	18	17	20	-	12.81

Waltham,	367	182	185	-	17	64	17	3	5	8	16	11	8	28	28	29	40	37	44	29	-	15.63
Ware,	174	90	84	-	10	61	18	9	4	-	3	-	1	10	11	8	14	16	9	10	-	21.06
Watertown,	162	78	84	-	10	34	5	3	3	3	3	1	3	18	13	15	15	18	20	8	-	16.68
Webster,	155	77	78	-	9	43	12	3	1	-	4	3	6	19	10	8	12	14	11	9	-	17.61
Wellesley,	61	26	35	-	2	9	3	-	1	-	4	2	2	1	9	3	7	7	9	4	-	12.03
Westborough,*	134	70	64	-	5	9	1	1	-	1	-	2	2	4	10	17	16	23	32	16	-	12.40
Westfield,	237	120	117	-	17	64	8	8	5	-	7	1	8	9	22	10	33	18	23	18	3	19.25
West Springfield	111	58	52	1	9	28	9	3	-	2	6	2	3	9	6	7	13	9	7	5	2	15.61
Weymouth,	184	95	89	-	18	21	4	1	2	2	2	1	5	15	16	10	29	28	30	18	-	16.25
Whitman,	91	36	53	2	6	14	2	1	2	1	4	2	4	10	8	5	7	10	12	9	-	14.77
Williamstown,	58	36	22	-	5	11	1	-	-	-	1	-	1	2	4	5	6	6	9	11	1	11.57
Winchendon,	86	32	54	-	8	21	8	1	1	-	6	3	2	4	4	5	2	12	9	8	-	17.20
Winchester,	83	38	45	-	3	19	5	1	-	-	1	-	3	2	3	5	10	8	18	8	-	11.43
Winthrop,	47	30	16	1	8	9	-	-	2	-	-	2	-	3	3	1	4	4	10	8	1	7.75
Woburn,	250	127	123	-	9	49	9	8	2	3	7	5	2	17	26	17	32	33	21	19	-	17.54
Worcester,	2,223	1,129	1,094	-	109	462	141	68	34	33	68	25	52	200	192	187	207	220	206	128	-	18.77
Total,	43,192	21,669	21,509	14	2,733	9,935	1,998	935	673	507	1,247	609	1,026	3,506	3,556	3,374	3,973	4,628	4,168	2,680	37	18.26

* Includes sixty-seven deaths at Westborough Insane Hospital. These deaths are not included in estimating the death-rate of the town.

Table III.

Deaths from Specified Causes in Cities and Towns having more than 5,000 Inhabitants in Each.

	Consumption.	Small-pox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping-cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Adams,	11	-	4	-	6	-	8	3	-	1	-	-	9	3	8	18	4	10	10	8	6	3	4	-	66
Amesbury,	23	-	1	-	2	1	5	9	-	-	1	-	8	5	1	9	4	17	21	9	13	-	2	-	15
Amherst,	8	-	-	2	-	-	-	5	-	-	2	2	2	-	1	16	-	9	7	5	4	1	1	-	33
Andover,	4	-	-	-	2	-	1	1	-	-	-	-	2	3	-	11	6	14	10	-	3	-	4	-	30
Arlington,	10	-	-	1	3	2	-	1	-	-	-	-	4	1	-	12	5	15	17	4	7	-	3	-	60
Athol,	4	-	-	-	2	-	1	-	1	-	-	-	9	1	-	15	-	12	3	4	4	1	-	-	41
Attleborough,	13	-	2	-	5	1	1	2	-	-	2	-	16	4	4	17	2	11	23	8	10	4	3	-	58
Beverly,	31	-	-	2	1	-	3	7	-	-	2	-	5	1	-	19	6	30	16	12	11	1	8	-	52
Blackstone,	6	-	-	1	5	1	4	3	1	-	-	-	11	2	-	15	2	3	1	7	1	2	5	-	54
Boston,	1,407	-	88	181	537	99	143	66	53	29	215	6	299	6	457	1,241	304	1,009	607	418	452	76	470	184	3,316
Braintree,	10	-	-	-	2	-	3	2	-	-	1	-	6	-	1	10	1	15	8	5	4	-	3	-	27
Bridgewater,	9	-	-	-	-	-	1	-	1	-	-	-	1	1	1	10	1	7	6	5	4	2	2	12	12
Brockton,	75	-	1	2	21	2	18	20	-	-	11	-	25	2	2	51	5	42	34	19	25	2	6	-	189
Brookline,	19	-	3	-	9	1	-	6	2	-	5	1	8	-	-	34	4	36	13	12	17	-	5	7	90
Cambridge,	207	-	-	9	72	12	15	2	4	5	13	-	78	3	58	152	48	122	141	71	69	9	53	121	282
Chelsea,	44	-	-	-	29	6	7	7	3	2	-	-	18	4	9	45	15	62	3	-	25	7	16	-	349
Chicopee,	26	1	2	-	4	1	5	1	1	-	6	-	39	1	6	42	25	16	65	10	6	1	8	4	128
Clinton,	19	-	2	-	4	7	1	4	-	1	-	-	4	-	19	17	6	12	-	8	3	-	9	1	85
Concord,	12	-	-	-	2	-	-	-	-	-	-	1	1	-	-	8	1	10	9	2	1	1	1	-	7
Danvers,	15	-	-	-	3	-	1	5	1	-	-	-	-	1	3	10	3	17	-	10	7	-	1	-	31
Dedham,	9	-	-	2	-	-	-	3	-	-	-	-	5	1	3	15	4	15	9	4	4	1	1	-	17
Easthampton,	5	-	1	1	3	-	2	2	-	1	-	3	2	-	-	9	4	9	-	2	2	-	1	-	51
Everett,	28	-	-	3	19	5	4	3	-	-	11	-	17	1	1	48	9	33	7	7	10	-	7	1	153
Fall River,	168	1	10	20	49	12	15	4	5	4	6	1	297	13	45	177	85	106	303	85	50	1	52	12	685

FITCHBURG,	32	-	1	3	13	3	10	2		-	1	-	34	5	5	42	13	46	3	11	17	1	12	-	214
Framingham,	24	-	-	-	1	-	2	-		-	9	-	6	1	-	27	5	21	10	11	5	-	7	-	71
Franklin,	8	-	-	3	1	1	3	3	1	-	3	2	3	3	2	8	3	11	16	3	4	1	3	-	27
Gardner,	20	-	1	1	6	1	1	8	-	-	7	-	16	2	5	15	6	20	31	12	6	6	8	2	62
GLOUCESTER,	40	-	-	2	10	1	1	-	1	2	10	-	11	-	5	16	6	50	51	23	18	-	10	5	119
Grafton,	4	-	-	-	1	4	1	1	-	-	-	2	5	-	-	7	1	9	-	3	3	1	4	-	44
Great Barrington,	5	-	-	2	1	-	-	-	-	1	-	-	7	-	-	8	-	12	12	7	3	-	2	-	19
Greenfield,	12	-	-	1	1	-	1	-	-	-	2	1	4	1	2	10	8	4	11	13	7	2	8	-	23
HAVERHILL,	66	-	-	1	11	2	6	4	3	2	17	4	8	1	4	66	11	63	51	34	26	6	21	6	152
Hingham,	7	-	-	-	1	1	-	3	-	-	1	-	5	-	3	13	4	11	12	4	2	-	-	1	23
HOLYOKE,	97	-	23	6	67	2	11	6	6	1	10	2	90	7	54	91	39	71	28	31	22	5	22	5	286
Hudson,	10	-	-	-	1	-	1	6	-	-	-	-	5	1	-	4	5	7	-	-	3	1	1	-	37
Hyde Park,	19	-	-	1	3	-	1	-	-	-	-	-	4	-	-	30	-	12	-	-	-	-	6	-	124
LAWRENCE,	114	-	18	7	33	5	11	2	3	1	10	1	143	9	6	123	37	99	14	18	27	5	23	15	526
Leominster,	17	-	-	2	7	-	3	6	1	2	-	-	10	-	1	15	7	19	7	9	9	-	4	-	61
LOWELL,	186	-	1	-	27	1	17	6	3	1	10	-	131	3	8	197	85	190	41	73	46	10	54	-	759
LYNN,	97	-	1	2	31	10	13	30	10	-	18	2	43	8	10	83	26	92	3	63	43	4	12	-	485
MALDEN,	55	-	-	4	17	3	7	1	1	1	-	-	24	3	4	32	12	48	6	14	26	3	7	2	223
Marblehead,	11	-	-	-	4	1	2	3	1	1	4	-	1	1	-	9	1	26	18	6	11	5	-	-	45
MARLBOROUGH,	22	-	-	-	3	-	-	13	-	-	-	-	19	7	1	20	3	17	1	8	9	1	1	-	81
MEDFORD,	13	-	2	-	11	5	3	-	14	-	12	-	14	-	1	22	7	13	-	4	9	-	6	-	108
MELROSE,	19	-	1	3	5	2	3	-	-	3	2	1	3	-	1	14	3	34	27	18	10	1	9	32	20
Methuen,	13	-	-	1	9	-	-	1	-	-	-	3	8	1	1	6	7	17	6	8	6	2	6	-	43
Middleborough,	13	-	-	-	1	-	1	3	-	-	2	-	2	-	-	13	2	14	5	5	8	2	4	3	59
Milford,	24	-	-	1	5	-	1	3	1	2	2	2	9	5	3	31	3	38	11	15	7	1	8	17	15
Milton,	9	-	-	-	2	-	1	-	-	-	1	-	1	1	8	12	1	9	16	3	11	3	1	-	15
Natick,	16	-	-	-	4	-	4	3	-	-	-	-	3	-	-	19	-	20	-	7	4	-	7	-	36
NEW BEDFORD,	85	-	6	14	5	6	22	6	3	2	9	-	125	3	7	129	47	106	74	61	41	1	11	-	522
NEWBURYPORT,	16	-	1	-	1	2	6	1	-	-	2	-	12	3	4	46	14	18	9	7	11	-	10	2	135
NEWTON,	37	-	-	1	28	1	9	10	1	3	9	-	24	-	1	54	11	50	47	14	19	1	11	-	171
NORTH ADAMS,	35	-	1	2	2	1	5	1	-	-	1	-	16	2	5	30	10	26	14	2	9	2	14	-	167
NORTHAMPTON,	37	-	1	4	6	1	10	-	1	-	5	3	19	1	4	20	16	35	48	12	17	-	13	9	108
North Attleborough,	9	-	1	-	3	-	-	1	-	-	3	-	3	-	-	14	-	7	15	5	1	1	2	-	41

TABLE III — *Concluded.*

	Consumption.	Small-pox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping-cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Northbridge, . . .	11	-	1	3	1	1	4	2	1	-	1	2	11	1	-	18	2	14	5	3	6	1	7	-	62
North Brookfield, .	12	-	-	-	2	-	-	2	-	1	-	-	9	1	-	6	1	9	1	5	3	2	2	-	20
Norwood, ...	6	-	-	1	3	1	-	4	1	-	1	-	7	-	-	6	1	11	6	6	1	1	1	-	21
Orange, . . .	10	-	-	-	-	-	4	4	1	-	2	-	1	2	-	2	4	7	12	4	8	-	6	-	20
Palmer, . . .	17	-	-	1	13	-	3	-	-	-	1	-	17	2	7	23	3	17	22	8	6	1	3	5	28
Peabody, . . .	28	-	-	1	2	2	2	4	2	-	2	1	8	-	3	11	6	20	26	6	13	4	1	-	75
PITTSFIELD, . .	26	-	1	-	5	2	5	4	1	-	-	-	14	3	4	30	9	44	4	6	13	2	8	-	244
Plymouth, . . .	15	-	-	1	3	3	1	1	-	-	2	1	2	2	-	21	4	27	23	16	11	2	5	27	17
QUINCY, . . .	40	-	1	-	17	2	4	3	-	1	7	-	13	2	24	29	15	46	40	10	10	1	8	4	68
Reading, . . .	6	-	-	1	-	-	-	1	-	-	-	-	-	-	1	6	-	5	1	3	2	-	-	-	69
Revere, . . .	18	-	3	1	7	2	1	-	-	-	-	-	5	-	2	19	3	17	12	6	7	-	4	-	33
Rockland, . . .	20	-	-	-	-	-	1	1	-	-	2	-	5	1	3	11	-	12	9	3	2	1	8	1	10
SALEM, . . .	38	-	-	5	24	19	9	1	2	-	20	-	32	18	-	53	25	58	17	26	30	-	17	-	310
SOMERVILLE, . .	102	-	-	7	49	3	9	26	8	-	15	-	51	2	3	111	36	81	9	42	27	1	31	-	354
Southbridge, . .	12	-	5	-	4	2	-	-	-	-	-	-	21	-	-	34	8	10	14	20	3	-	3	46	37
Spencer, . . .	13	-	1	-	-	-	1	4	-	2	-	-	6	-	4	19	1	6	2	7	5	-	-	4	40
SPRINGFIELD, . .	97	-	6	2	24	4	17	5	6	6	19	-	111	-	-	124	35	95	30	105	48	8	30	48	323
Stoneham, . . .	14	-	-	3	2	-	2	-	-	-	-	-	4	1	-	5	3	6	25	10	4	-	2	-	11
Stoughton, . . .	11	-	-	-	1	-	1	3	-	1	2	-	11	-	-	6	3	7	5	9	5	-	1	-	53
TAUNTON, . . .	68	-	7	-	3	1	8	-	2	-	6	3	45	2	40	64	16	54	5	26	17	3	3	1	282
Wakefield, . . .	10	-	-	4	5	-	3	6	-	-	1	-	1	-	-	12	2	7	10	2	6	1	6	21	22
WALTHAM, . . .	45	-	-	-	27	1	5	1	-	3	3	1	6	4	5	41	4	33	26	22	18	1	10	3	108
Ware, ...	11	-	11	-	-	8	-	-	-	-	-	1	22	-	1	26	2	8	2	11	3	-	5	3	60
Watertown, . . .	18	-	-	1	6	1	5	10	-	1	2	1	5	1	4	21	2	16	3	7	5	1	9	-	43
Webster, . . .	17	-	1	-	1	-	3	-	-	-	-	-	24	-	6	16	3	6	2	-	1	-	2	-	73

Wellesley,	6	-	-	-	1	1	-	-	-	1	3	-	-	-	1	13	1	3	5	3	4	3	-	1	15
Westborough,	5	-	-	-	-	-	2	3	-	-	1	-	-	1	-	10	7	5	57	10	4	2	2	-	25
Westfield,	22	-	-	1	9	-	7	4	-	-	2	-	22	-	1	26	2	33	22	11	3	4	12	-	56
West Springfield,	12	-	1	3	4	-	2	1	-	-	-	1	9	-	-	14	1	17	6	4	-	-	5	1	29
Weymouth,	29	-	-	-	3	-	4	5	1	-	3	-	3	-	1	15	5	34	23	9	5	-	4	13	27
Whitman,	17	-	-	-	2	-	2	4	-	1	-	-	5	-	-	10	-	12	2	-	3	-	1	2	30
Williamstown,	6	-	-	-	1	-	-	1	-	-	-	-	3	-	3	3	5	7	6	3	2	1	1	-	16
Winchendon,	7	-	1	1	3	3	1	1	-	-	-	-	4	-	1	7	-	10	11	1	6	-	-	-	29
Winchester,	6	-	-	-	2	2	-	-	1	-	1	-	2	-	3	8	4	4	12	3	4	-	3	-	28
Winthrop,	1	-	-	-	1	-	-	-	-	-	3	-	2	2	-	6	-	8	5	2	5	-	1	-	11
WOBURN,	29	-	-	1	6	1	1	1	1	-	1	3	5	-	1	19	1	28	3	6	7	2	1	-	133
WORCESTER,	250	-	24	36	55	34	32	4	8	5	13	2	173	12	25	278	52	197	190	96	69	14	57	-	595
Total,	4,390	2	235	358	1,387	296	533	385	158	87	538	53	2,333	178	907	4,350	1,203	3,821	2,553	1,730	1,544	233	1,231	621	14,029

Homicide.

Amesbury,	1
BOSTON,	15
BROCKTON,	1
CAMBRIDGE,	1
Clinton,	1
Dedham,	1
HOLYOKE,	2
Milton,	1
North Brookfield,	3
PITTSFIELD,	1
WORCESTER,	2

Malignant pustule.

Bridgewater,	1
West Springfield,	1

Glanders.

FITCHBURG,	2
Framingham,	1
Milford,	1

Tetanus.

Framingham,	1

Malignant Papilloma.

NEWBURYPORT,	1

Table IV.

Deaths from Specified Causes, 1900. Death-rates per 10,000 (1896-1900). Deaths per 1,000 from All Causes, 1896-1900.

Causes of Death.	Deaths. 1900.	Mortality per 10,000 of the Population.					Deaths per 1,000 from all Causes.				
		1900.	1899.	1898.	1897.	1896.	1900.	1899.	1898.	1897.	1896.
Consumption, ...	4,390	18.56	17.91	18.41	19.01	20.60	101.60	103.70	107.01	105.00	106.75
Measles, ...	235	0.99	0.66	0.34	0.57	0.53	5.44	3.80	1.99	3.13	2.72
Scarlet fever, ...	358	1.51	0.84	0.53	1.32	1.06	8.29	4.85	3.09	7.27	5.50
Diphtheria and croup, . .	1,387	5.87	3.99	2.74	5.75	7.20	32.12	23.08	15.94	31.78	37.30
Whooping-cough, . . .	296	1.27	1.11	1.43	0.72	1.01	6.85	6.41	8.28	3.98	5.22
Typhoid fever, . . .	533	2.25	2.31	2.49	2.37	2.77	12.34	13.40	14.50	13.08	14.33
Cerebro-spinal meningitis, .	385	1.63	1.73	2.12	2.59	1.54	8.91	10.03	12.35	14.31	7.97
Erysipelas, ...	158	0.66	0.50	0.33	0.44	0.52	3.66	2.88	1.94	2.44	2.70
Puerperal fever, . . .	87	0.37	0.20	0.23	0.27	0.37	2.01	1.17	1.36	1.52	1.91
Influenza, ...	538	2.28	1.57	0.68	1.10	0.52	12.44	9.09	3.93	6.09	2.67
Malarial fever, . . .	53	0.22	0.21	0.30	0.23	0.28	1.23	1.20	1.76	1.28	1.44
Cholera infantum, . . .	2,333	9.87	8.20	10.18	9.69	13.22	54.10	47.45	59.14	53.55	68.52
Dysentery, ...	178	0.75	1.00	0.94	0.79	1.48	4.12	5.79	5.45	4.39	7.65
Diarrhœa and cholera morbus.	907	3.84	1.84	2.44	2.00	2.47	21.00	10.67	14.16	11.02	12.80
Pneumonia, ...	4,350	18.40	17.89	15.08	17.18	17.76	100.70	103.60	87.66	94.92	92.04
Bronchitis, ...	1,203	5.09	5.18	5.60	5.81	6.04	27.88	30.00	32.56	32.07	31.31
Diseases of the heart, . .	3,821	16.16	14.85	14.84	14.81	15.35	88.45	86.00	86.22	81.84	79.53
Diseases of the brain and spinal cord.	2,553	10.80	11.99	12.50	13.23	12.41	59.00	69.42	72.61	73.08	64.31
Diseases of the kidneys, .	1,730	7.32	7.13	6.57	6.42	6.87	40.05	41.30	38.17	35.43	35.62
Cancer, ...	1,544	6.53	6.06	6.32	6.04	6.12	35.75	35.07	36.70	33.35	31.73
Suicide, ...	233	0.99	1.07	1.06	0.98	1.06	5.39	6.18	6.16	5.40	5.50
Accident, ...	1,231	5.20	5.20	5.56	5.21	5.68	28.50	30.12	32.30	28.80	29.42
Unknown or ill-defined causes,	621	2.63	2.56	2.26	2.77	3.15	14.38	14.80	13.10	15.30	16.30
All causes, . . .	43,192	182.60	172.70	172.10	181.00	193.00	-	-	-	-	-

HEALTH OF TOWNS.

HEALTH OF TOWNS.

The following extracts have been made from such published reports of local boards of health as have been forwarded to the State Board for the year 1900.

The prominent topics which have been noted in these reports are the increased prevalence of diphtheria during the past year, and the need of isolation hospitals for infectious diseases in those cities and large towns where they have not yet been provided.

Another important topic is the growth of the local health laboratory. The establishment of the bacteriological laboratory of the State Board of Health in 1895 was soon followed by others in the principal cities. While the State Board still offers facilities for the examination of material sent by local boards for the diagnosis of disease, the establishment of laboratories by local boards has relieved the State Board of those which would, in time, have proved to be a serious burden. At present the work of this character performed by the State Board is quite widely distributed, but a very large share of the material forwarded to the Board comes from places in the metropolitan district. In a few instances, local boards of health, at a considerable distance from Boston, as in the case of Springfield, have given material assistance to towns in their own neighborhood. In this city the agent of the local board of health has established a well-equipped laboratory, where chemical and bacteriological work is performed not only for the city of Springfield but also for many other places within a radius of fifty miles.

The following numerical statement of bacteriological work has been compiled from the published reports of local boards of health for the year 1900 : —

Bacteriological Work in Massachusetts Cities and Towns in 1900.

Cities and Towns.	Throat Cultures for Diphtheria.	Examinations for Tuberculosis.	Examinations for Typhoid Fever.	Examinations for Malaria.	Packages of Diphtheria Antitoxin produced, of 1,500 Units each.
Boston,*	18,889	1,021	1,014	38	-
Brookline, ...	3,503	83	61	-	-
Brockton, ...	468	-	-	-	-
Cambridge, ...	2,876	174	149	-	-
Fall River, ...	206	-	48	-	-
Fitchburg, ...	299	31	90	-	-
Lowell, ...	402	106	61	-	-
Lynn, ...	696	-	-	-	-
Newton, ...	912	-	31	-	-
Palmer, ...	62	-	-	-	-
Springfield, ...	1,304	-	-	-	-
Waltham, ...	3,486	49	-	-	-
Worcester, ...	2,845	-	-	-	-
State Board of Health,	5,173	746	62	78	53,389

* One hundred and nineteen examinations for glanders.

This portion of the report also contains the results of the investigations of the Board which have been made by Dr. Morse, inspector of the Board, acting under its direction, for the purpose of aiding local boards of health in the investigation of the prevalence of infectious diseases in cities and towns. The increasing frequency of epidemics of typhoid fever which are traced to the use of milk from dairy farms at which unsanitary conditions are found on inspection, is worthy of special note.

Amesbury.

This is the first year any attention has been paid to care of bakeries. We have made thorough inspection of every bakery in town, and have recommended certain improvements and posted notices in every shop as to just what rules to follow. Our recommendations and notices have received the attention of the bakers in an acceptable manner, and have been fully carried out; consequently we report the bakeries of the town in good condition.

Special attention has been paid to the sewerage on and about Huntington Avenue and Maple Street to Powow River. We have examined these places and improved same to the best of our ability, but we are placed in a position where nothing of any value can be done until we get a general sewerage system.

We have supplied the town through the summer months with a team to collect the decayed material from the stores.

There have been but few cases of diphtheria, and antitoxin has been supplied for nearly every case. We have not had reports from the users

of this as exact as we should like to have them, and this will be demanded the coming year.

The law should be enforced that no pupil could enter the public schools until he or she has been vaccinated.

Andover.

The following report of an inspection made by Dr. F. L. Morse, medical inspector of the Board, relates to an epidemic of diphtheria which occurred at Andover in the spring of 1900 : —

On March 15, Mr. X., a milkman residing in North Reading and selling milk in Andover, came to this office with the statement that a number of cases of diphtheria had appeared among customers using his milk, and, as a certain suspicion rested upon the milk as the cause of the disease, he desired an investigation made. After communicating with the local board of health of Andover, I went there on March 19 to ascertain the origin of the cases, if possible, and to institute methods to prevent its further spread.

The first case to appear which was recognized as diphtheria was on February 23, in a boy six years of age, who attended the Dove school. The exact origin of his infection cannot with certainty be stated, but it is known that his teacher was ill with tonsilitis on February 7, and that soon after her return to school he was taken ill. No cultures were taken from her throat, and it is possible that diphtheria germs may have been present, and not have disappeared at the time she resumed her duties.

Following the appearance of this case in the Dove school, eight other children attending the same school were taken ill with the disease, the last one having been taken ill on March 15. On further investigation it was found that fourteen of the remaining cases obtained their milk from Mr. X. He supplied milk to two boarding-houses where a large number of students of the Phillips Andover Academy boarded, and ten of these students subsequently came down with the disease. Three of the remaining cases are also known to have had access to Mr. X.'s milk, and one of the latter cases also worked in the rubber shop located in the town. He was taken ill on March 3, and on March 7 two other cases working in the same factory were also taken ill, probably by direct infection from the first case. Of the remaining fourteen cases, eight of them were among school children attending other schools, and six among patients from whom it was not possible to learn the origin of their infection.

After conference with the local board of health, it was decided to temporarily close the Dove school and thoroughly disinfect it, and also that the two boarding-houses above mentioned, after the cases present in them had recovered, be thoroughly disinfected with formaldehyde.

In regard to Mr. X.'s milk supply no definite information could be obtained pointing to a recent case of diphtheria at the farm or among those who had the care of distributing the milk ; but about three weeks later the hired man who distributed the milk was himself taken ill with diphtheria, and transferred to the Boston City Hospital for treatment. It is not possible to state whether or not the germs of the disease lay dormant in his throat while he was at work and distributing the milk to the families where cases subsequently appeared, for at that time

he showed no indications pointing to the illness, and consequently no cultures from his throat were obtained.

Following the directions above given, the epidemic came to a close, and only one case of the disease appeared after March 20. The board of health was further advised not to release the quarantine upon cases until negative reports had been obtained from the throats by bacteriological examination.

Arlington.

In diphtheria, while the mortality was only six per cent. (in marked contrast to that of forty-five per cent. before the days of antitoxin), the number of serious cases was large. Scarlet fever also was extremely severe. Twenty-one families were affected with the latter disease, and forty families with diphtheria. These families were widely scattered, and not supplied by the same milkman. Occasionally there is a year when contagious diseases seem to be widely epidemic. Such a year has been the past, for not only has Boston been unusually affected, but nearly every suburb within miles of this centre. It has been suggested that one cause of the prevalence of these diseases in Arlington is the large area of fertilized ground in town; but many of the neighboring towns and cities have suffered much more than ours, and yet their amount of fertilized ground consists only of their public gardens and private flower beds.

The sanitary conditions of the town were never so good as during the past year. Sewers have been extended, many cess-pools abandoned, and all unsanitary conditions improved, if not perfected. Antitoxin has been very freely used in the treatment of all diphtheria cases, and with the most gratifying results. Only three cases have died, and one of these was practically beyond help when medical aid was first summoned.

In all cases of contagious disease the public ought to be governed by rules made for the limitations of such diseases, based on the scientific investigations of the best medical minds of the day.

Co-operating with the school board, a medical inspector of schools has been appointed, whose duty it is to daily inspect each school and temporarily suspend any suspects of contagious disease.

During the past year there has been considerable discussion regarding the keeping of swine within the limits of the town. The Board has carefully considered all complaints in relation to this subject, making personal inspections of all places where such animals are kept, and have required a strict compliance with the town by-laws.

Athol.

The town has been particularly free from infectious or contagious diseases during the year, and there has been no epidemic. The contagious diseases reported have been isolated cases, and have occurred in various sections of the town, there having been but few cases in any one locality.

The Board has consulted with the school authorities, and special care is exercised in the promiscuous use of school supplies, so that there will not be a dangerous interchange of these among the pupils, especially as regards the use of pencils, etc.

The owners of bakeries have been notified that they must keep their premises in such condition as conforms with the requirements of the law, and notices containing the laws regarding bakeries and persons employed in them have been posted in all the bakeries of the town.

Belmont.

We have been very fortunate in being able to send to the Waltham Hospital a number of patients ill with diphtheria, thereby insuring thorough treatment and minimizing the chances of further contagion. Through the co-operation of the school committee and the superintendent of schools great care is being exercised to prevent spreading of this disease by the school children.

Through the united action of the Cambridge and Belmont boards of health the channel of Wellington Brook has been widened, straightened and deepened from its mouth, where it enters Little River in Cambridge, to the point where it crosses Concord Avenue in Belmont, a distance of over a mile. As a result of this work, some thirty acres of land in Belmont, which have been under water most of the time for the past ten years, will be available for farming next season. In some places the water in the vicinity of Hill's Crossing has been lowered over three feet.

Beverly.

Early in October quite a number of cases of typhoid fever were reported. The board caused an investigation to be made. Dr. Morse of the State Board was notified, and a separate investigation of each case was made. It was found that a large majority of all the cases reported had obtained their milk supply from one party outside of the city. It was found that this party had one case of typhoid in his family, and from one place where he had obtained a supply of milk there were five or six cases of typhoid. It was deemed desirable to immediately cut off this supply of milk from being delivered here, and that party was at once notified to discontinue delivering milk in this city until further notice. The result was apparent, as only three cases were reported during the remainder of the month, two of which could be traced to the same source.

The following report of Medical Inspector Morse relates to an epidemic of typhoid fever which occurred at Beverly in the fall of 1900 : —

During the latter part of September and the early part of October, from the weekly reports of infectious diseases received at this office, it was apparent that an unusual number of cases of typhoid fever were present in the cities of Beverly

and Salem, and on October 4 an investigation was begun to determine the origin of the cases.

The attention of the local board of health of Beverly had been called to these cases, and a partial investigation had been made by them, with the discovery that a majority of the patients ill with the disease had obtained their milk from one supply. With this information at hand the investigation was pursued upon these lines, and it was found that, of twenty cases of the disease appearing in Beverly and six in Salem, twenty-two of them obtained milk from one dealer. Of the four remaining cases, probably one of them contracted the disease while out of town on a vacation, and concerning the other three no information could be obtained relative to the source of their infection.

A visit was made to A.'s farm in the town of Ipswich, he being the milkman supplying these families. He had six cows at his farm, yielding about fifty quarts of milk daily, which he distributed to families in Beverly and Salem, most of his trade, however, being in the first-named city. As an auxiliary supply, he obtained four cans from B.'s farm and one can from Mr. C. All of this milk obtained from these different sources was mixed, with the exception of one can, which he supplied to a family by the name of D., and which was milk obtained from his own cows. Upon questioning him in regard to the presence of typhoid fever at his home, it was ascertained that he himself had been ill with the disease fifteen years previously; and that at the present time his son, twenty-one years of age, was ill with the disease, having gone to bed on September 18. It was a part of the son's duty to assist his father in the collecting and delivery of the milk, and it was noted that several days preceding his going to bed he was in a somewhat weakened condition, probably from the invasion of the disease. It was further ascertained that at Mr. B.'s farm seven cases of typhoid fever were present, the first one coming down with the disease on September 11. The six other cases came down on or about the 20th of the month, which would indicate that the infection of the latter was obtained directly from the first patient.

The well at Mr. A.'s house had been dry since the 1st of August, and he obtained his water temporarily from Mr. E.'s spring near by. A sample of this water was obtained, and found upon analysis to be polluted. At about the same time in August the well at Mr. B.'s farm became dry, and he temporarily used water obtained from a spring in a field some eighth of a mile distant from his house. The water from this spring had a distinct odor of sewage, and upon analysis it was found to be polluted, but not to such an extent as the odor of the sewage would indicate. Samples of water were also taken from Mr. F.'s farm and Mr. G.'s, where a temporary supply was also obtained, and both of these wells were found polluted.

The first case at the B. farm was a boy nineteen years of age, who assisted his father in milking and supplying the milk to Mr. A.; and it is a significant fact that at the same time a relative of his visiting the house and using the same spring water was afterward taken ill at his home with the disease, thus confirming the supposition that the original infection existed on this farm.

The boards of health of Salem, Beverly and Ipswich were informed of the results of the investigation, and each took measures to prevent the further spread of the disease, with the result that after October 11 only one other case developed in the town of Beverly, and that one could not be attributed to this particular milk supply.

BLACKSTONE.

The following report of Medical Inspector Morse relates to an epidemic of typhoid fever which occurred at Blackstone in the fall of 1900: —

During the latter part of September the board of health of Blackstone, through their representative, Dr. Melifant, notified this Board of the appearance of a number of cases of typhoid fever in the village of Millville, and requested that an investigation be made in regard to their origin.

On September 20 I made a visit to the town and a personal visit to each of the patients who had the disease. The local board of health had been negligent in reporting to this Board the appearance of all infectious diseases, as required by chapter 302 of the Acts of 1893, and the attention of the board was called to this omission, and a request was made that in the future all cases of infectious diseases should be duly reported. It is apparent at the present time that little or no attention was paid to this request, for no such reports have ever been received.

From an investigation of these cases it was found that nineteen patients were ill with typhoid fever, all of whom had gone to bed since September 6, when the first case appeared. Two other cases developed on the 7th, two on the 11th, two on the 12th, four on the 13th, two on the 14th, three on the 15th and one each on the three following days. It was apparent, therefore, from the dates obtained, that the infection was of continued duration rather than one of limited extent. It was also determined that the milk supply was not at fault, for all of the patients had no common supply. The village of Millville has no public water supply, and the drinking water is obtained, usually for each house or group of houses, by wells located upon the premises. The water supply of the rubber factory, in which it was found upon inquiry that all of the patients worked, was obtained from a driven well located in the factory yard and adjacent to the Blackstone River. A sample of water was taken from this well, and upon analysis was found to be considerably polluted, and not subsequently purified in its passage through the ground. The rubber factory was closed from August 4 to August 15 on account of a lack of business. On the latter date it was reopened, but closed again on September 8, since which time, to and including September 20, it has been closed. All of the patients, therefore, used the well water at the factory during the time from August 15 to September 8, and from the subsequent date of their going to bed it can be readily seen that this period corresponds to the incubation period of the disease. The fact that no other cases of the disease appeared in the village except those employed in the rubber shop, although they were exposed to other possible common sources of infection, would indicate that the cause of the disease was to be found at the rubber shop; and the polluted well water supplied to the employees was determined as the probable source of infection.

In connection with the investigation, five other samples of water were obtained at the houses where the patients lived. These were subsequently analyzed, and in every instance were found to be polluted to a considerable extent, but some of them were, however, subsequently purified in their passage through the ground. The board of health was informed of the result of the investigation and of the

analyses of the samples of water obtained, and advised to adopt measures to prevent the further development of the disease.

In view of the fact that no cases of any infectious disease have since been reported from this town, it is impossible to state whether or not any other cases of typhoid fever developed; but the probable source of pollution having been pointed out to the board of health, it remained for them to remove such source of infection.

Boston.

A statement of the sanitary condition of the city, as called for, may be approximately given by a brief review of the changes which have taken place within a few years and the conditions as they exist to-day.

The water supply of Boston is well provided for. It is of good quality, ample in quantity, and well protected by law against the danger of pollution, and with the most trustworthy custodians.

The food supply is in abundance, of excellent quality and under good supervision. The principal markets are kept scrupulously neat, and are a credit to the city. Meat, fish, fruits and vegetables arrive in the city in better condition now than ever before. Some small markets, pedlers on the streets and Saturday evening venders of meats and other provisions are less neat and trustworthy, and continue to need particular watching. The milk supply was never better. It is faithfully watched by the Bureau of Milk Inspection, and all places for its production, detention and sale are now under regulations of this department and watched with care. Owing to the unsatisfactory condition of the milk drawn from cows in the sale sheds at Brighton on Tuesdays and Wednesdays of each week, and the difficulties in the way of securing anything like cleanliness in handling it, the Board was compelled to order all such milk to be turned into the public sewer as soon as drawn. Since the order was issued no such milk has been used as food from that place.

The abattoir in Brighton is the only place left in the city for the slaughtering of animals for food, and this is provided with a competent and trustworthy inspector, who is on constant duty at that place.

Offensive trades and employments have been regulated and made less noisome and dangerous. Bone-boiling and fat-rendering establishments, lime kilns, phosphate works and a variety of other offensive trades are less in number, and nearly all have undergone such modifications as to be comparatively unobjectionable and rarely complained of. Soap factories and gas plants have ceased to be intolerable nuisances and have become inoffensive manufactories.

In the last fifteen years 8,889 privy vaults have been discontinued by order of the Board, and only rarely has one been built during this time, and then only as a practical necessity. The same is true to nearly the same extent with cess-pools, which are now allowed only in the absence of sewers and for surface water.

Dead animals, such as horses, mules, pigs and goats, are quickly removed from the city without expense, on notification to the proper parties.

Eighty-three old stables, which were practically worn out and unfit for repairs or so badly situated as to be a serious annoyance to occupants of other buildings, have been removed by order of the Board during the last four years. Other stables have been vigorously altered to conform to reasonable sanitary conditions. Stables are now permitted only upon conditions for better sanitary construction and care, and the storing of manure on the premises for more than twenty-four hours will soon be prohibited.

The streets, although better paved than formerly and somewhat cleaner, are nevertheless too rough and uneven on the surface for economical and comfortable use or for the economical and necessary cleaning.

The "lanes," "alleys" and "courts" of the city are generally in a bad sanitary condition, and subject to a great deal of complaint. These places, nominally private, are receptacles for all sorts of waste material, and no one assumes the care, as a rule, until forced by order of the board of health or the courts. A small improvement in these private alleyways has taken place within a few years. Under a law passed a few years ago the city has laid out and paved a few of these alleyways at the expense of the abutters, and the city is made responsible in the act, for keeping such alleyway "free from any substance which is liable to cause sickness or a nuisance." This is a singular way of saying that the city must keep them clean, if that is what was intended.

The tenement-house population is large, and composed generally of a class of persons who are too poor or otherwise indisposed to promote cleanliness and healthful conditions. This is a great drawback in any city, and Boston does not differ greatly in this respect from most other large cities. A very large amount of our work is done in the tenement houses, and a fair amount of improvement in their conditions can be seen as a result.

The lodging houses and their occupants have been most radically changed from the unwashed tramp in his day clothes, sleeping on the floor, on settees or filthy beds, in unclean, unventilated and overcrowded places; we have clean, light and ventilated dormitories, supplied with such necessary furnishings and conveniences and under such rules and care as health and cleanliness require. The number of lodging houses has greatly diminished, owing to stringent regulations.

Barber shops had become in many instances unclean, and for want of proper sanitary care had become a source of danger to health. They have been placed under regulations, greatly improved, and are under constant supervision.

The plumbing and gas-fitting in buildings have been brought to a higher standard of excellence, which has diminished the risk to life and greatly increased the healthful conditions.

The docks have been greatly relieved from the ingress of sewage and other wastes, and are gradually improving.

The tide water flats have been considerably reduced in area by filling. Those remaining are less offensive as a whole than formerly, but in places the condition of the flats at low tide is bad, needs attention and will be mentioned elsewhere in the report. There are still some drains discharging overboard from private property, but these drains are being cut off as fast as practicable.

Vacant lots are much less used for the deposit of rubbish and filth than was formerly the case, and the means for making owners clean them up are much greater.

Mortality. — The total number of deaths for the year was 11,678, — an increase over the previous year of 511 deaths. The population by census in the middle of the year is 560,892. The death-rate for the year, as calculated on this population, is 20.82 per 1,000 inhabitants. This rate is more by .70 than that of the previous year, and with three exceptions the lowest on record.

During the past year the board adopted and published new regulations in regard to barber shops, ice dealers, the slaughter of poultry, refuse and manure removal, milk, contagious diseases, the spread of glanders by horseshoeing shops, the storage of rags and other refuse, offensive trades, public funerals.

The following regulations in regard to the sale of ice were adopted: —

Ordered, That each and every party selling ice in Boston fill out, over the signature of the chief clerk or other responsible officer of the party, and return to the board of health at its office, Old Court House, Boston, Mass., on or before June 1 of the year, a blank of the following form: —

1 Give the name and situation of each and every river, brook, pond or lake from which you cut ice, and the approximate number of tons you cut annually from each.

2. Give the name of each and every party from whom you take ice to sell, and the approximate number of tons taken annually from each.

3 Give the situation of each and every storehouse, depot, agency, railroad terminal or other place from which you take your ice into vehicles for distribution in Boston.

4. Give the name of each and every party distributing ice in Boston, to whom you regularly or occasionally supply ice, and the approximate number of tons supplied to each.

5. Do you classify the ice you sell as "For drinking purposes," "For cooling purposes only, not to be used for drinking"? etc.

6. Do you sell "snow ice"?

7. Do you flood your ice field?

8. Do you have chemical analyses made for you of the water used or of the ice therefrom?

9. Do you take precautions to maintain your sources of supply in good, clean and wholesome condition, and, if so, what?

The following regulation was adopted relating to milk: —

No milk drawn from a cow in the city of Boston within forty-eight hours after said cow is brought into said city shall be sold or used for human food, and all milk drawn from any cow within forty-eight hours after said cow is brought into said city shall be destroyed within one hour after it is drawn from the cow.

Contagious Diseases. — At a meeting of the Board of Health, Dec. 24, 1900, the regulation respecting contagious diseases, adopted July 1, 1895, was amended so as to read as follows: —

Whoever is infected with small-pox, scarlet fever, diphtheria or croup, shall immediately proceed to some isolated place or room designated by the board of health, and no person who has been so affected shall leave such place or room, and no article shall be removed from such place or room, until the board of health shall certify, in writing, that all danger of communicating such disease to others is passed.

Every parent or guardian of any child or ward infected with small-pox, scarlet fever, diphtheria or croup, shall immediately cause such child or ward to be conveyed to some isolated place or room approved by the board of health, and no parent or guardian shall permit such child or ward to remove from such place or room until the board of health shall find and certify, in writing, that all danger of communicating such disease to others has passed.

No person other than the attending physician, nurse and agents of the board of health shall enter any apartment or other place set apart for the treatment of small-pox, scarlet fever, diphtheria or croup, until the board of health shall certify, in writing, that such apartment or place has been satisfactorily disinfected.

No person having the care of any other person who has been affected with small-pox, scarlet fever, diphtheria or croup, shall advise or permit such other person to leave any place designated by the board of health as a place of isolation of such infected person before said board of health shall have certified, in writing, that such person can leave such designated place without danger to others.

No physician who has been in attendance upon any person who has been infected with small-pox, scarlet fever, diphtheria or croup, shall advise or knowingly permit such person to leave any place designated by the board of health as a place of isolation of such infected person before said board of health shall have certified, in writing, that such infected person can leave such place without danger to others.

In cases of small-pox, all crusts resulting from the pustules must have disappeared, and the patient and all infected articles be disinfected before being released from isolation.

In cases of scarlet fever, all traces of desquamation must have disappeared, and the patient and all infected articles be disinfected before being released from isolation.

In cases of diphtheria, all traces of the false membrane must have disappeared, two consecutive negative cultures from both nose and throat be obtained (the second one to be obtained by an agent of the board of health), and the patient and all infected articles be disinfected before being released from isolation.

Horseshoeing Shops. — *Whereas*, the board of health is of the opinion that walls, hitching-bars, chains and ropes in horseshoeing shops to which animals affected by a disease known as glanders have been secured are liable to become the means of spreading said disease to healthy animals subsequently secured to such walls, hitching-bars, chains and ropes, it is therefore *Ordered*, that the walls, hitching-bars, chains, ropes or other apparatus in horseshoeing shops to or by which horses may at any time be secured shall be thoroughly disinfected by the proprietor of such shops with a five per cent. solution of chloride of lime at the close of each day's business.

Disinfection. — The following table shows the work of disinfection during the year at the expense of the department: —

Diphtheria, number of houses after,	4,977
Scarlet fever, number of houses after,	1,710
Phthisis, number of houses after,	685
Measles, number of houses after,	71
Small-pox, number of houses after,	7
Chicken-pox, number of houses after,	11
Cancer, number of houses after,	14
Typhoid fever, number of houses after,	7
Glanders, number of houses after,	205
Bedding, etc., lots,	112
Books, lots,	358
Clothing, etc., lots,	135
Carriages,	31
School-houses,	105
Rooms disinfected,	13,798
Materials used: —	
Formaldehyde, forty per cent. solution (gallons),	2,897
Alcohol for heat (gallons),	1,481
Chloride of lime (pounds),	55,624
Bi-chloride of mercury (pounds),	1,175
Chloride of sodium, in mixing (pounds),	1,200
Nuisances abated,	17,882

Hospital for Consumptives. — A year ago the board of health called for reports of all cases of consumption affecting the lungs and throat, with a view of isolating as many of the cases as might seem best, giving instructions to all, and disinfecting after every removal of such a case. The work has progressed favorably, with the aid and approval of the medical profession and the community. The one thing lacking in making this work more effective is a well-located and accessible hospital for patients in the advanced stages of the disease, and where the necessary treatment and security against the spread of the disease cannot otherwise be obtained. On May 1, 1900, the board issued a circular to consumptives and those living with them.

School-houses. — At the request of the school committee the board made an examination of the sanitary condition of all the school-houses, and reported upon the same.

Medical Inspection of Schools. — The system of school inspection inaugurated in Boston several years since has gradually been adopted by other cities and States, and is now generally recognized as most important in the early discovery and treatment of infectious diseases, and also in pointing out many other diseases and disturbing physical conditions in the public schools. A review of this work by the superintendent of public schools, in his last annual report, gives a gratifying endorsement to medical inspection of schools as practised here. He calls attention, with characteristic clearness, to the faulty condition of our laws pertaining to school attendance of children without vaccination, and the return of children to school after recovery from infectious diseases. In 1894 our statute law concerning vaccination was amended so as to allow unvaccinated children to attend school if they could obtain from a physician a certificate stating that they were unfit for vaccination. The result has been that children in excellent health are being certified as unfit for vaccination, and are in school without the precaution against small-pox which the law formerly required. It is only a question of time, in our judgment, when the evil of the amendment will be realized in the presence of small-pox.

The subjoined table gives the results of school inspections: —

Summary of List of Diseases found in the Schools by the Officials appointed by the Board, 1900.

Specific infectious diseases,	505
Oral and respiratory diseases,	2,609
Diseases of the ear,	87
Diseases of the eye,	431
Diseases of the skin,	3,421
Miscellaneous diseases,	3,568
Found free from disease,	4,952
Number of pupils examined in the schools,	15,573
Number recommended to be sent home,	3,055
Number consultations with teachers (about pupils returning to school, etc.),	3,440

Bacteriological Department. — The report of the bacteriologist treats of the following subjects: —

The first part describes the laboratory methods used in the routine diagnostic examinations of specimens from suspected cases of tuberculosis, diphtheria, typhoid fever, malaria, glanders, rabies, etc., and a brief outline of the principles involved in the interpretation and application of laboratory findings to every-day practice.

Mallein is now supplied free to veterinarians for use in cases of suspected glanders.

The second part of the report gives the results of the routine work, and of certain special investigations concerning disinfection by sulphur, infection of clams, etc., the relation of blank cartridge wounds to lockjaw, and arsenic in calcimine.

The appendix contains most of the tables illustrating the work.

Culture examinations for diphtheria,	18,889
Examinations for tuberculosis,	1,021
Examinations for typhoid fever,	1,014
Examinations for glanders,	119
Examinations for malaria,	38
Examinations for other diseases,	44
Vaccinations,	4,118
Examinations for small-pox (of which 7 proved to be small-pox),	53
Quarantine: —	
Vessels stopped for inspection,	697
Admitted to quarantine hospital: —	
Small-pox,	2
Diphtheria,	2
Leprosy,	1
For observation,	15

Animal Inspection.

Animals killed at abattoir: —	
Cattle,	22,680
Calves,	22,015
Sheep,	14,891
Swine,	26
Total,	59,612
Animals condemned (of which 159 were cows),	162
Diseases found: —	
Tuberculosis,	150
Septicemia,	10
Sarcoma,	1
	161

Percentage of Tuberculosis in Cattle killed at Abattoir.

Class of Animals.	Number received.	Number Tubercular.	Percentage.
Whole number of all kinds,	22,680	310	1.36
Cows from eastern States,	6,336	308	4.86
Bulls from eastern States,	1,702	–	–
Cows from western States,	1,063	–	–
Bulls from western States,	60	–	–
Steers from western States,	13,517	–	–
Steers from eastern States,	–	2	–

Under the head of "Cows from eastern States" is understood animals from all of the New England States, including Massachusetts.

The total number (310) of tuberculous cattle found at the abattoir during the past year shows a large increase as compared with the total number (234) found during the year 1899. This, however, is due to the great increase in number (6,336) of eastern cows killed during the past year, as compared with the number (3,936) killed during the year 1899; although the percentage (4.86) of tuberculous eastern cows found during the past year is lower than the percentage (5.89) found in the same class of animals for the year 1899.

Inspection of Cattle. — The inspection of cattle kept for the production of milk within the city limits has been continued as heretofore. All cattle that have upon physical examination shown any symptoms of tuberculosis have been subjected to the tuberculin test. Forty-six animals have been tested with tuberculin, of which seven were found tuberculous and quarantined. These were at once reported to the Board of Cattle Commissioners, in accordance with the Public Statutes.

Glanders. — There have been reported by veterinarians to the board of health during the past year 224 horses under the suspicion of having glanders. Of these, 52 on examination were found to be affected with some non-contagious disease, and the remaining 172 proved to have glanders. Twenty-four of these cases, upon inquiry, were found to have been owned and stabled outside of Boston, or had been stabled in Boston for so short a time that no doubt existed but that the animals were infected with glanders before coming to Boston. The State Board of Cattle Commissioners were notified of such cases, thus enabling them to investigate.

In addition to the above cases of glanders reported to this office, the board of health, by examination of all animals in stables where a case of glanders occurred, and also in many other stables, found 33 cases of glanders, or 16 per cent. of the total number of cases, all of which would otherwise have remained in such stables, a constant danger to the other animals, for some time before being discovered by the owner. During such stable inspections 4,500 horses have been examined.

Milk Inspection. — The number of samples of milk examined was 13,978, of which 8,149 were taken from milk wagons, 5,621 from shops and restaurants and 208 were brought in by citizens. Of the total number, but 2 were found to contain added coloring matters and only 13 contained preservatives. These 13 samples were obtained from seven dealers, all of whom were prosecuted and convicted.

The number of samples of butter, oleomargarine and cheese examined was 1,137, less than 50 of which proved to be oleomargarine, and these were mainly from restaurants and boarding houses where transient trade is solicited. An occasional fraudulent dealer doing business from a wagon strays into the city limits, but the business of selling the prohibited article

as and for butter is practically dead. No new legislation was passed concerning butter and oleomargarine by the Legislature of 1900.

The number of samples of vinegar taken during the year was 805. As in former years, the quality has been in general very high.

Prosecutions,	323
Convictions,	287
Inspection of provisions: —	
Total number of packages seized and condemned,	3,211
Meats: —	
Beef, ham, pork, poultry and veal (pounds),	22,868
Game (pounds),	291
Fish: —	
Haddock, cod and lobsters (pounds),	1,510
Also many packages of fruit and vegetables.	

Braintree.

The Braintree bakery was found to be in a very unsanitary condition; this has been cleaned, however, and changed to the requirements of statute and sanitary laws. All dumps in the town have been inspected and cleaned. The shores of Little Pond, which is now the source of our water supply, have been carefully inspected, and in one place a sink drain found running directly into the pond was ordered abolished, and a water-tight cess-pool has been built instead, as far as it is possible from the pond. Many buildings already built are much too near the shore, but the owners, by care and with the advice of this board, have abated much that might pollute the water. Increased care of this pond must be taken as the town grows, that we may save our present good water. We would respectfully call the attention of the citizens of the town to the necessity of acquiring the land immediately adjacent to Little Pond as an added protection to this supply.

Brockton.

At the suggestion of its health officer, the board would earnestly repeat its recommendation of the past two years for a daily inspection of the schools of the city by local physicians, under the advice and direction of the board.

The determination of the board to enforce an ordinance against spitting on the floors of street cars and public buildings met with popular approval at once. Especially was this so on the part of the patrons of the City Theatre, where the practice of spitting tobacco juice on the floors, particularly on the floor of the upper gallery, had grown to a disgusting and alarming extent. Five or six persons have been arrested and fined for violating the ordinance. The nuisance of spitting in public places has been almost entirely abated, and the board is seriously considering the question of apply-

ing the same ordinance to the matter of spitting on the public paved sidewalks and street crossings.

The action of the board in causing all the stock at rummage sales to be fumigated before passing to purchasers was prompt, and met with general commendation, and was followed by similar action by health boards in other places. Such a collection of miscellaneous articles, being principally composed of cast-off clothing, gathered promiscuously from all sorts of out-of-the-way places, mostly old closets and trunks, may well be viewed with suspicion, if not alarm.

We wish to call the attention of the city council to the growing need for a contagious disease hospital. The past year has fully demonstrated to the board the necessity of such an institution. We should have some suitable place where can be isolated such cases of scarlet fever and diphtheria as cannot be treated at their own home without great danger to other members of the family and consequently to the community.

This year for the first time the board has insisted on a negative result on the bacteriological test before release from quarantine. This work, although done out of town, has been done by one of our best bacteriologists in the State, and in a manner highly satisfactory to the board. It is the intention of the board to require two negatives next year.

The following report of Medical Inspector Morse relates to an epidemic of typhoid fever which occurred at Brockton in January, 1900: —

On January 30 Dr. F. J. Ripley, chairman of the board of health of Brockton, came to this office with the information that an unusual number of cases of typhoid fever existed in that city, and requested that an investigation be made to discover its cause, and that the board be advised relative to its control.

I accordingly went to Brockton on the following day, and obtained a list of all cases of the disease reported to the local board of health, supplemented by others which had not been so reported. I then made a personal visit to each patient, to determine if possible the source of infection, and found that each and every one of them had access to the milk of a single dealer. Subsequent to this date other cases were reported to the board, and on further investigation it was found that this fact was still present. The cases numbered twenty-one altogether, eleven of them being among children, most of whom went to school, but not always to the same school, and the remainder among adults with different occupations. The sanitary conditions about the several houses where cases existed were also investigated, but no common source of infection could be found except the milk.

This being the probable source of infection, a visit was then made to the house of the milkman, Mr. A., and further information obtained relating to the source of the milk, the manner of washing the cans and the distribution of the milk. It was found that two teams were in use to supply the customers, one being driven by the milkman himself and the other by his son ; and it was seen that all of the cases of the disease, with but two exceptions, were on the son's route ; but it was further learned that, although these two cases received their milk personally from Mr. A., still, it was the milk supplied by the son's team that they really did re-

ceive, which resulted in the following way. These two patients lived in a locality inconvenient for the son to supply, but on the route usually supplied by Mr. A. on his way home. Before getting home, however, it was customary for the son to leave what milk he had left after supplying his customers at Mr. B.'s on Spring Street, which place his father passed some time later, and picking up this milk, supplied it to his last customers, among whom these two cases of the disease developed. It is thus seen that the infection undoubtedly existed in the son's milk, and not in his father's.

All of the cans and bottles were washed daily at home by Mrs. A. The well from which the water was obtained for washing these cans was under the shed, the water was drawn by a chain pump, and an analysis showed it to be considerably polluted. From all information that could be obtained and from investigation at the house, it was evident that the infection of the milk did not take place here, even if the well water did show pollution; for it is fair to assume that, if this was the source of pollution, both routes would have an equal number of cases upon them, while it has been shown that they existed entirely on one route.

The cans after being washed were carried to the farms and left there to be filled the following day, when they were collected and the milk distributed to the customers directly from them, with but few exceptions. These exceptions were fifteen quart bottles which were filled daily by Mrs. A. with milk obtained from C.'s farm, and supplied to the customers by the son's team; this proved to be the clue by which the infection was subsequently traced, for two cases of typhoid fever appeared among the customers who used this milk, and never had access to any other supply.

Mr. A. obtained the milk delivered by himself from eleven different farms, each supplying from one to five cans daily, and, as the cases of the disease had not appeared on his route, it was thought unnecessary to investigate them further.

His son obtained his milk from four farms, as follows: C. supplied eleven cans daily, D. and E two cans each, and F. one can, so that the bulk of his supply came from C.'s farm.

Each of these farms was visited and the conditions noted, but at no place could the history of any case of typhoid fever be found. Concerning Mr. E.'s milk, it was stated that one family by preference had his milk and no other supply, and that no case of sickness had appeared among the family; and in regard to D.'s and F.'s supply it can be stated that they were of too limited amounts to produce the large number of cases which appeared, particularly when the milk had not been previously mixed. Furthermore, as stated above, two cases appeared among families who had access to C.'s milk and to no other supply; and the son, who was also taken ill with the disease on February 7, stated that he always drank C.'s milk, because he thought it was of better quality than the other supplies.

At C.'s farm it was learned that eight cows were kept, and that Mr. C. did all of the milking himself. The water for the house was usually obtained from a well in the yard, but it had been dry during the latter part of the summer and most of the fall, on account of the dry weather. When this water was not available, water was brought in a pail from a well located in a field some hundred yards distant, and, as an additional supply, a large hogshead was located at the

barn corner, which collected water from the roof of the barn. It was stated that this supply was used only for watering the cattle; but it may be assumed to have been used at other times for washing cans and pails, on account of the distance of the second well from the house. The second well, one hundred yards distant from the house, was located in a field adjacent to a brook which carried the drainage from the road close by and also from some pasture land farther away. At the time of one of my visits the brook was overflowed and covered the top of the well to a height of about a foot or more, and under such conditions the well could not help but be polluted from any infection near by. Samples of water were collected from both of these sources, and showed evidence of pollution.

The fact still remained that, although the probable source of infection was the milk supply from this farm, still, the specific source could not be found, although it possibly may have been one of the three sources of water supply existing there; and, on account of the length of time in which the cases developed, extending from Nov. 27, 1899, to Feb. 7, 1900, a period of over two months, it can be asserted that the infection was of a constant character, rather than one of short, specific duration.

The local board of health were informed of these facts as rapidly as they were discovered, and were immediately advised to suppress the sale of milk from Mr. C.'s farm until such a time as he secured a suitable water supply. This advice was followed by the board, and, as a result, only three other cases of the disease developed, and none went to bed after February 7, five days after such notification. The result of the analysis of the water at Mr. A.'s farm also showing considerable pollution, they were advised to seek another supply.

Brookfield.

The following report of an inspection by Medical Inspector Morse relates to an epidemic of typhoid fever which occurred at Brookfield in September and October, 1900: —

During the early part of the month of October my attention was called to a number of cases of typhoid fever appearing in the town of East Brookfield, and on October 10 I made a visit to the village for the purpose of investigating the origin of the disease. I found a total of twenty cases which had appeared in this town since the early part of August.

The first case was a boy seventeen years of age, who went to bed on August 10. He lived on a farm producing milk, which was distributed among the inhabitants of the village, and consequently the existence of this case was a focus of infection to the customers supplied with this milk. The water supply of the house was obtained from a well located near the back room of the house, the water being brought to the surface by a bucket and chain arrangement. A sample of it was obtained, and upon analysis found to be most seriously polluted.

Another boy, ten years of age, in this same family, was taken ill on September 23, probably by direct infection from the existing case, and information was obtained which showed the existence of six cases of the disease here forty-five years ago, one case about twenty years ago and another case two years ago.

In addition to the pollution obtained from the natural drainage of the ground

towards the well, some of the wash water from the sink undoubtedly entered it, as the sink drain was only ten feet distant, and the water flowed on the surface of the ground.

Four cases of the disease were found to have used milk from this one supply, but in addition they used water from wells which, upon examination, showed evidence in some cases of very serious pollution, and in one instance there is a history of five cases of the disease appearing at the house the year previous.

Among the other cases four obtained milk from one dealer, six from another, and the remainder had various supplies; but there was no history of typhoid fever appearing on any one of the farms.

Samples of water were taken from two of the houses where cases existed, and the water was found to be very badly polluted.

The board of health was informed of the result of these analyses and of the probable infection existing in these wells; but, as the town has no public water supply, it seems rather difficult to improve the local conditions until such a system has been introduced. Most of the cases appeared during the middle and latter part of the month of September, and at the time of my visit only one case had been reported during the first ten days of October.

Brookline.

Cases of chicken-pox that closely resembled small-pox have been reported to the Board, and in each case thoroughly investigated. The building used for small-pox patients is kept in readiness for use, but so long as each and every citizen does his duty in regard to protecting himself and his household (including his servants) by vaccination and occasional revaccination, the building is likely to remain vacant. The laws made for the protection of school children against small-pox and other contagious diseases are more faithfully lived up to at present than for several years past, an improvement largely due to the cordial co-operation of the superintendent of schools.

The diphtheria epidemic that prevailed throughout almost the whole of eastern Massachusetts during the fall and early winter found Brookline still unprovided with adequate hospital accommodations. The board met the situation, however, by erecting close to the old diphtheria building a fairly comfortable structure, that received from twelve to twenty patients, according to the urgency of the occasion. This was put up in a week, and was used for patients who were less ill than the others, and for those who had become convalescent, the old building being reserved for the more serious cases. Later it was found necessary to use the so-called probation ward and the small-pox building (not used for small-pox for six years) to accommodate patients that needed hospital isolation and care, thus bringing up the number of patients at the hospital at one time to thirty-five. The absence of an isolation hospital at such a time would have meant a large increase in the number of cases of diphtheria in the town, not to mention great loss of schooling for many children, for most of the patients

in the hospital came from crowded tenements in the more densely populated districts.

A new ambulance, constructed according to plans prepared by the agent and the bacteriologist of the board, has given great satisfaction. It is made as far as possible to resemble, outwardly, a common depot carriage, to avoid unpleasant conspicuousness, but at the same time possesses every essential of the best form of ambulance. It has a rear door as well as side doors, and every modern appliance for moving safely and comfortably the sickest patient, whether child or adult, and, furthermore, is easy to disinfect. The ambulance is kept at the hospital, and when going for a patient one of the nurses usually accompanies the driver.

The medical inspection of the public schools and of the parochial school has been made as circumstances required, at times daily, at other times every second day. During a part of the year they seemed unnecessary, and were therefore wholly suspended until needed. These inspections are paid for by the health department. As a result of this work and the liberal use of cultures in the schools, it has not been necessary to close a school, or even a single room, the past year.

Considerable pains have been taken to trace the spread of typhoid fever and diphtheria to infected milk, but no conclusive evidence was found.

The free bacteriological examinations provided by the board for the early diagnosis of diphtheria and typhoid fever have been much more extensively taken advantage of the past year than in previous years, and with great benefit to both patients and their families. To encourage parents and others to have cultures made early in all cases of sore throats, the board in October gave notice that any person having a sore throat and unable to employ a physician could send direct for any one of the medical inspectors of schools, to decide by a culture whether he had diphtheria or not. The board also authorized its agent to send a school inspector to make the required cultures for release in cases of diphtheria infection, where the family can ill afford to pay for such service. Any physician who has in his care such a patient may communicate with the agent of the board. These measures have given satisfactory results for all concerned.

Formaldehyde disinfection of rooms, bedding, etc., after scarlet fever and diphtheria, has been continued, and proves to be effective. After cases of these diseases the disinfection is done by the disinfector appointed by the board, and is done free of expense where the householder is unable to pay for it.

During the past year 449 samples of milk, 28 samples of butter and 17 samples of vinegar have been examined.

Cambridge.

The diseases discovered in the schools, and the number of cases, were as follows: —

Chicken-pox,	30
Diphtheria,	18
Measles,	42
Mumps,	2
Pediculosis,	179
Scabies,	5
Scarlet fever,	5
Whooping-cough,	5
Diseases of ear,	22
Diseases of eye,	118
Diseases of skin,	93
All other diseases,	341
Total,	860

The number of cases reported from individual schools ranged from one to sixty-seven.

Owing to the large number of cases of diphtheria occurring in the latter part of 1899, the board of health took up and opened for the reception of patients the temporary hospital. The first patient was admitted Dec. 7, 1899, and the last patient was discharged April 27, 1900, and the house closed. It became necessary to reopen this temporary hospital in October of 1900, and the first patient was admitted on the 29th of that month. From that date to the end of 1900 there have been admitted fifty patients, of which number four have died, twenty-eight have been discharged well and eighteen remained under treatment on Dec. 31, 1900.

Death-rate per 1,000 Living, from All Causes.

1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.
19.24	19.44	20.89	19.56	18.40	18.87	17.93	17.65	17.25	16.83

The mean annual death-rate for the ten years, 1891 to 1900, inclusive, was 18.60.

Clinton.

Diphtheria has been more prevalent than for several years. In addition to the usual methods of isolation and disinfection, the added precaution has been taken of requiring evidence by a bacteriological test that the patient has not only recovered clinically, but also that the throat has become free from the presence of the bacilli which caused the disease.

Formaldehyde has been used for the disinfecting of one hundred and thirty-eight rooms in dwelling-houses, besides twenty-seven large school-rooms and three corridors which have been exposed to infections as a result of the various cases of contagious and infectious disease occurring during the year.

Concord.

We think that our low death-rate is directly traceable to the added care our citizens have given to all methods of sanitation.

We have continued to maintain two dumps, one at the foot of Brister's Hill and the other on Law's Brook Road.

The work of the inspection of plumbing has largely increased this year, owing to the fact that so many of our citizens have availed themselves of the opportunity of entering their plumbing into the sewer.

We have purchased a large formaldehyde machine, and have found it very useful in fumigating the schools and large rooms in private dwellings. This work is also largely increasing, fumigation being now used in cases of consumption and typhoid fever, as well as diphtheria and scarlet fever. We would earnestly recommend that after the removal of any patient suffering from consumption notice be given the board of health, in order that the rooms occupied by him may be fumigated.

Danvers.

There has been a considerable epidemic of diphtheria in the town during the year. A great many cases here were of a mild nature and recovered quickly, while others of more severe character were speedily cured with diphtheria antitoxin. Most of the cases reported occurred in children attending the Maple Street grammar school; therefore, by order of the board, on October 22, both school-houses were closed for a period of two weeks, during which time several rooms were thoroughly cleansed and repaired and many of the books destroyed; also the cup and pail system for drinking water was abolished, and the new fountain system established.

It was noticed after this closing of the schools that no new cases occurred for a period of two weeks or more, after which new cases began to be reported. It was then found that, because of mild cases constantly occurring in families where no medical attendance had been employed, the epidemic was still continuing. We then inspected the schools from time to time, with the assistance of the teachers and school committee. All cases of illness, and especially sore throat cases, were reported to the board, and by this means some cases of unreported diphtheria were discovered, and the children so afflicted kept at home.

Very few realize what a saving it is to the people of the State to have the antitoxin manufactured by the State Board of Health, which not only supplies the people with antitoxin free, but also furnishes culture tubes and makes examination of cultures of diphtheria, the only cost to the town being

that of sending the parcels to the State House. If people were obliged to purchase antitoxin of drug houses, it would cost them thousands of dollars more than the present expense to the State annually. The quality of the antitoxin has improved during the past year.

We think it necessary, for the safety of the community, that there should be an inspection of the schools from time to time, and especially during any epidemic of contagious disease.

Everett.

Our city, in requiring at least one negative culture before discharging the case from quarantine, is following the custom of cities like Boston, where at least two negative cultures are considered necessary to the public weal.

The longest quarantine for diphtheria has been eighty days, the average length being twenty-two days.

There were four hundred and sixty-eight cultures taken, one hundred and eighteen being for diagnosis. There were one hundred and nineteen cases reported without cultures being taken, showing that in half the cases the disease was of so mild a form that it could not be positively recognized by the ordinary symptoms. Three hundred and fifty cultures were taken for release; of this number, one hundred and forty-eight were positive, and without a culture being taken many of these cases would have been discharged before danger from contagion was over. The low death-rate was due to the mildness of the disease in many cases and the early use of antitoxin in most cases, this remedy being used by practically all our physicians.

In the opinion of the board, a regular medical examination of our schools cannot much longer be postponed with safety.

Fall River.

Physicians, householders, school teachers and all citizens are required by the regulations and the Public Statutes to report all cases of contagious diseases immediately to this office. This also includes the reporting of any well-founded suspicion of the existence of any contagious disease. That this law should be observed is of the greatest importance, for upon the promptness with which the board is informed of the existence of any contagious disease much depends. The difference of only a few hours may sometimes mean a great deal, especially in cases of diphtheria, where the patient's life may depend upon the prompt administration of the remedy (antitoxin) which experience has demonstrated as almost infallible if applied promptly. Then, again, the earlier quarantine is established and the nature of the disease made known, the better chance is given those not affected to escape the contagion. Many cases of scarlet fever, diphtheria

and other diseases could have been avoided if the rule to promptly report to the board the appearance of the first case had been thoroughly understood and complied with.

In addition to enforcing its regulation prohibiting spitting upon the floors of public buildings, halls, street cars, steamboats and all public conveyances, the board provides for the thorough disinfection of all rooms or tenements which have been occupied by persons afflicted with tuberculosis.

The total cost of this epidemic of small-pox to the city was $15,996.25, including the completing and refurnishing of the pest house and the maintenance of the people there and under quarantine throughout the city.

Fitchburg.

In May the board took a forward step by placing examinations for typhoid fever, tuberculosis, glanders and pneumonia on the free list as is done in most cities of any importance, to increase the efficiency of the work of our department. This action increased somewhat the labors of the bacteriologist, and also the expense, but the results of it are sufficient to warrant the additional expenditure.

The following conclusions are stated by the bacteriologist relative to an epidemic of diphtheria at West Fitchburg: —

It seems clear to me that, had the milk been infected *at the farm*, the cases of diphtheria on the milk route would have appeared several weeks earlier, at least; the fact that they did not appear until *after* the infection of the throat of the young man who *delivered* the milk seems to prove that he was unwittingly the source of contagion. He delivered not only milk, but also diphtheria bacilli, either by actual contact, or else by getting them in some way into the milk delivered at certain houses, or into the receptacles for the milk. No blame is to be attached to him or to any member of the family. They have all shown themselves reasonable since the throat infection was discovered, and have been willing to do all they could to make things right, and I trust this little unpleasant episode will not damage them or the milk in the future. The whole matter shows that we must be on the lookout, and I would recommend that, in future cases of virulent-fatal diphtheria, cultures be taken from the throats of all members of the household before releasing from quarantine.

A building to which cases of contagious diseases that could not or would not be properly quarantined might be immediately removed would be a great benefit to the public, and materially lessen the danger of contagion. The new building of the Burbank Hospital will soon be ready for occupancy, and now is the time to grasp a golden opportunity, and secure the present hospital building, soon to be vacated, for a contagious hospital.

There is a great need of having a medical inspector, who shall be physician of the board. The Public Statutes (chap. 80, sections 5 and 6) provides for such an officer. Numerous cases have arisen during the year, such as

vaccination of school children, inspection of school-houses, taking of release cultures for diphtheria, identification of contagious diseases, etc., where the services of a regularly appointed and authorized physician of the board were needed. Either the board should be allowed to appoint such a medical inspector, or else the city ordinances should be so changed that the city physician can act in that capacity.

The following report of Medical Inspector Morse relates to certain cases of glanders which occurred at Fitchburg in July, 1900 : —

On July 17 a communication was received at this office from a physician of Fitchburg, containing the information that he had two patients under his care in which he suspected that the disease was glanders, and I accordingly went to Fitchburg to obtain information relative to these cases. The two patients were B., age, fifty, and his son C., age, eighteen.

From the history it was learned that one of Mr. B.'s horses was taken to the camp of the First Brigade at South Framingham on June 23, for use by one of the officers, and returned on June 30, at which time he showed symptoms of illness. A veterinary physician was called, and, on account of the value of the horse, it was determined by Mr. B. to do everything possible to save him. Assisted by his son, he gave the horse the medicine prescribed by the veterinary physician, but their efforts were futile, as the horse became worse, and died on July 8. On the same day Mr. B. was taken ill, complaining of general symptoms of malaise, a sore throat, weakness and a high fever. Dr. A. was immediately called, and, as the symptoms were suspicious of typhoid fever, he prepared a specimen of the blood for examination, which, however, was negative.

Two days later Mr. B.'s son was taken ill, complaining of pain in the right side, with some cough and slight secretion from the nasal passages. His constitutional symptoms were much the same as his father's, — closely resembling typhoid fever; but when the history of the horse was obtained, the probable diagnosis was changed to one of glanders.

From this time on both patients failed rapidly, and certain of the subcutaneous glands in the extremities were enlarged, tender, and eventually suppuration appeared. Injections of mallein were given to both patients, but with apparently no beneficial results, as they both subsequently died, as a result of the constitutional poisoning produced in the course of the disease.*

Franklin.

During the months of February, March and April the town was visited with an extensive epidemic of scarlet fever. Fifty-eight cases of that disease occurred in Franklin during the year. It is greatly to be regretted that early in the epidemic there were those who did not realize the necessity for strict quarantine, and were induced, from motives best known to themselves, to interfere with the efforts of this board to stamp out the disease. Professional incompatibilities, in which we cannot think the people generally have much interest, and which most certainly ought to have nothing to do

* See "Journal of the Massachusetts Association of Boards of Health," January, 1901.

with matters of quarantine and sanitary regulation, seem to have operated to hinder and obstruct the board of health in carrying out its proper and required work.

The following reports of Medical Inspector Morse relate to epidemics of scarlet fever and typhoid fever at Franklin, one of which is referred to in the foregoing extract from the report of the local board of health.

On March 20 an anonymous letter was received at this office, containing information that an epidemic of scarlet fever existed in the town of Franklin, and that the usual precautions taken in such cases had not been observed. It was further stated that a case of the disease existed at Elm Farm in the village of Unionville, and that the milk from this farm was distributed about the town, and a certain amount of it sent to Boston. I accordingly went to Franklin on March 23 to investigate these cases.

The first case to appear was in November of 1899, since which time thirty-four cases of scarlet fever had been reported to the local board of health. As the investigation proceeded, it was evident that the local board of health was somewhat impeded in preventing the spread of the disease by one of the practising physicians of the town, who, it is said, stated to his patients that the board of health had no authority to quarantine his cases, and told them that they might go about the town as usual; in fact, somebody went so far as to take down one of the red flags placed by the local board of health at a house where scarlet fever existed. Other legal technicalities were also presented to me by both parties, but concerning which I refused to offer any opinion.

After consultation with the local board of health, I advised them regarding the usual ways of preventing the spread of scarlet fever, and that they give definite directions to the householder wherever a case appeared. Formaldehyde had never been used as a disinfectant in the town, and I also advised the board to procure a supply, and thoroughly disinfect each house with it after the patient had recovered.

These measures seemed to be efficacious in stopping the disease, for in the following month only four new cases appeared.

During the latter part of September and the early part of October it was apparent that an unusual number of cases of typhoid fever was present in the town of Franklin, and in a communication from the chairman of the board of health, Dr. G. A. Martin, a request was made for advice relative to the cause of the disease.

On October 5 I made a visit to the town, and found that there were twenty-three cases of the disease which had been reported since September 20. Visits were made to their houses, the date of their going to bed obtained, and all other information relative to the origin of the disease. In five of these cases the origin of the disease could not be definitely stated, the patients having various milk and water supplies, and no common source of infection could be ascertained. In the seventeen remaining cases it was found that eight of them had milk of one milkman and the remaining nine of another milkman.

A visit was made to the first farm, and it was learned upon inquiry that no case of typhoid fever had been present. It was ascertained, however, that a daughter of the farmer who had used this supply was ill with typhoid fever, and

had been one of the first to go to bed. She lived some distance from the farm, but it is possible that some of the infection in her case was carried by means of the milk cans subsequently distributed to the other customers becoming ill with the disease.

Of the nine cases developing from the other supply, all were in three families, four existing in one, two in another and three in the third, and these were the only families supplied by this dealer. He kept only one cow, and the amount of milk was consequently limited. The surroundings about this place were entirely unfit for the production of milk, for the barn was small and poorly ventilated, the family was poor and unable to keep help, and when the milkman's wife was taken ill during the early part of this epidemic the man himself nursed her and did most of the housework, besides attending to the duties about the place and the distribution of the milk. Two of his children were also subsequently taken ill with the disease.

In the family where two cases appeared there were only three in the family, the third member being an elderly woman, who probably was immune to the disease, and in the family where four members were ill the entire family contracted the disease.

The board of health, through its chairman, was made acquainted with the conditions existing at this farm and with the results of the analyses of several samples of water taken in the course of the investigation. These samples were obtained from wells at some two or three houses where patients were ill, and at the farms in question. In every instance all of them were dangerously polluted, and it was advised that new supplies be obtained.

During the month of October seven other cases appeared, but it could not be definitely stated that infection was received from the sources above discovered. With the presence of the disease in the town, however, it would be possible for the infection to spread in some other manner than through milk supplies.

Gardner.

In reviewing our work during the past year it is gratifying to find that there is a steady improvement in the care of cess-pools, water-closets, surface drainage and the running of filthy matter into our streets, and that the number of pig pens is steadily decreasing.

Total number of animals examined for tuberculosis,		818
Cattle,	598	
Swine,	200	
Sheep,	20	
Total number quarantined for tuberculosis,		21
Total number killed as tuberculous,		18
Number of horses killed, affected with glanders,		2

Greenfield.

The bakeries have been inspected from time to time, as the law requires. In some of them much could be done in the way of cleanliness. This fault is mainly due to neglect, and when attention is called to the matter, the

suggestions of the board have been carried out cheerfully. This experience shows, however, the importance of inspection in this class of business.

Since the month of June the town has been very free from contagious diseases. Previous to that time scarlet fever was more or less epidemic, continuing into this year from last. In March last it seemed practically stamped out, but it suddenly sprang up again, and a mild epidemic continued until June, when it ceased.

The following regulations, together with others, are published by the board: —

Rule 8. — No swine shall be kept without a special permit in writing from the board of health, and then only in such places and manner as they may direct, within those portions of Greenfield in certain specified limits.

Rule 11. — In all cases of diphtheria, diphtheritic sore throat and membranous croup the patient will be held in quarantine until the attending physician or the board of health shall have received a negative culture from the state board of health.

Haverhill.

The following report of Medical Inspector Morse relates to certain cases of typhoid fever which occurred at Haverhill in February and March, 1900: —

On March 3 a letter was received at this office from Mr. Chester Bryant, agent of the board of health of Haverhill, containing the information that ten cases of typhoid fever had appeared in that city in a period of eight days, dating from February 22; and in a subsequent letter, dated March 6, it was stated that nine more cases had been reported to the local board of health, and that they would like assistance in tracing the source of the infection. I accordingly went to Haverhill on the following day, and obtained a list of all cases reported to date, with the histories which had been obtained from the patients by Mr. Bryant.

During the month of January, 1900, four cases of the disease had been reported, one on the 7th, two on the 20th and one on the 27th; but upon obtaining their histories, it was seen that they had nothing in common with the cases appearing later.

The next case to develop appeared on February 12, and up to the end of the month, a period of sixteen days, twenty-two cases of the disease appeared, showing that some unusual condition had suddenly appeared, to which a portion of the inhabitants of the city had been exposed. The disease continued to spread, but to a less extent, during the month of March, and up to April 2 thirty-seven cases have been reported.

On examining the histories of the patients, it was seen that fifteen of them were among children attending school, and the remainder among adults, most of whom were shoe operatives and clerks, but all of whom were not employed under the same conditions. In regard to their milk supply, it can be stated that almost without exception each patient had a different milkman, and consequently infection could not occur in this way. Such was not the case in regard to the water supply, however, for upon investigation it was found that with but three exceptions all of the

patients had access to Kenoza Lake water, one of the city's public water supplies, and in sixteen of the cases no other water supply. Of the three exceptions, case No. 2 had Crystal Lake water, No. 3 had Johnson's Pond water, and No. 36 probably contracted the disease at Boston, for he was taken ill eleven days after coming to Haverhill.

Kenoza Lake water being considered the probable cause, a visit was made to the lake, to discover, if possible, the specific source of infection, and attention was first directed to the Haverhill City Hospital, which is located upon the water-shed of the lake. During December, January and most of the month of February three cases of typhoid fever were cared for at the hospital. While these patients were ill in bed it is to be believed that their discharges were disinfected in an efficient manner, but upon partial recovery, and while the patients were up and about the ward and before they were able to go to their homes, it is known that the discharges did go into the sewer in an undisinfected condition.

The sewage is conveyed from the hospital through a drain pipe a distance of about fifty feet to a cess-pool, which when full overflows into another cess-pool some twenty feet away, both of which are located between the hospital buildings and the lake, the land sloping toward the latter. It was also apparent that at times the second cess-pool did overflow, and at the time of my first visit the contents of it could be seen flowing on the ground toward the lake in considerable amounts. From further study it was also apparent that a system of underground drains existed upon this land, for in two different locations ridges of earth could be distinctly seen, which when followed along eventually came together lower down in the field, and the contents of the drains flowed into the gutter on the side of Kenoza Avenue. It was also evident that some of the cess-pool water entered these underground drains, in addition to what was seen overflowing on the top of the ground. The natural drainage of this field, with which the sewage mixed, flowed a distance of some four hundred feet with quite a rapid descent to the gutter on the side of Kenoza Avenue, was then carried through a culvert and Akron drain pipe under the avenue, and could be seen emerging on the opposite side, where it was conveyed by means of a covered drain some two hundred feet, then into an open drain some fifty feet farther, emptying into a small basin, which, when full, overflowed into Kenoza Lake within two hundred feet of the intake of the water works.

It is stated above that *at times* it is apparent that this condition of affairs does exist, and the conditions were such that they did exist just previous to the outbreak of the epidemic. On account of the dry fall and winter season, up to January 1, the basin into which this drain flowed was practically dry, and no water flowed into the lake from it; but with the advent of the heavy rains during the latter part of January and February the cess-pools at the hospital were both overflowed and their contents rapidly washed down into the basin, which, when full, overflowed into the lake. The rainfall on January 25, as registered at the pumping station, was .9 of an inch; on January 28 and 29, 1.9 inch; on February 4 and 5, 1.4 inch; on February 9, 1.0 inch; and on February 12 and 13, 2.5 inch, — a total of 7.7 inches in a period of eighteen days, certainly an unusual state of affairs.

The Haverhill board of health were informed, through their agent, of this being the probable source of infection, and were advised to notify the inhabitants using this supply of the danger existing; and, furthermore, to boil all water before using it for domestic purposes. This notification was made on March 9.

As a further preventive of the infection, both cess-pools at the hospital were cleaned and the contents removed; but, on account of the existence of the under-drains and the continued use of the sewers, it was not possible to entirely remove the infection.

The chemical examination of the water from the lake showed no particular change, but a bacterial examination of samples taken on March 9 was as follows: —

Sample from Lake, near Place of Overflow from Small Basin.

Bacteria in cubic centimeter,	1,332
B. Coli in cubic centimeter,	2

Sample from Lake, Fifty Feet from Intake.

Bacteria in cubic centimeter,	94
B. Coli in cubic centimeter,	0

thus proving conclusively that intestinal pollution of the lake had taken place.

The water-shed of the lake was further investigated, and other sources of pollution found. The house of the engineer of the pumping station is located within a few feet of the shore of the lake, and the sewage of the house is carried to a large cess-pool near by. This cess-pool is cleaned out by the water board as occasion requires, and it is not known that its contents have ever overflowed into the lake, but, on account of its location, it is certainly a menace to the public health. Still nearer the shore of the pond is located a hen house, containing at times from fifty to one hundred and fifty hens. It is not known that this is a dangerous source of pollution to the water, but it is certainly a condition which ought not to exist on any public water supply.

Across the street from the pumping station are three houses with sewage connections, the contents being collected in a cess-pool in the rear, which is cleaned at frequent intervals. This cess-pool is made of brick, lined with cement, is apparently water-tight, and was constructed under the direction of the local board of health. It is apparent that little or no pollution would take place from this source.

There is still another source of pollution from another house and barn on the opposite side of the street from the pumping station. This house has a cess-pool which collects the sink drainage from the house, and the privy is located in the barn, the contents being discharged upon the barn cellar. The natural drainage of this land is toward the lake, and at the time of my visit a foul-smelling and dirty stream could be seen flowing from this barn cellar downward through a field into the gutter of Kenoza Avenue, then in under the street mixed with some surface drainage, directly into the lake, only a few feet from the intake pipe.

Other sources of pollution which existed were the natural drainage of the land on the north-westerly border of the lake and along Kenoza Avenue. All of this drainage is conveyed in the gutters on either side of the avenue down to a point opposite the pumping station, and there conveyed by underground drains directly into the lake, near the intake pipe.

During the months of January and February ice was cut on Kenoza Lake, and this fact was considered in regard to possible pollution of the lake. Careful inquiry, however, revealed no history of any illness among the workmen, and as

the ice, for the most part, was cut on the lake quite remote from the intake, it is hardly to be considered as the source of infection. In connection with the ice, however, the question appeared as to whether it would be safe to use for domestic purposes, having been cut from a water supply known to have caused an epidemic of typhoid fever. Accordingly a sample of ice was examined chemically and bacterially with the following result: —

Chemically.

Free ammonia,	.0040
Albuminoid ammonia, total,	.0124
Albuminoid ammonia, in solution,	.0084
Nitrates,	.0030
Nitrites,	.0006
Oxygen consumed,	.0400

Bacterially.

	Top of Cake.	Middle.	Bottom.
Bacteria,	8	3	31
B. Coli in 100 cubic centimeters,	0	0	0

Two other samples of water were taken, on March 19, corresponding to the samples taken March 9, with the following results: —

	Bacteria.	B. Coli per Cubic Centimeter.
No. 1,	118	0 in 100
No. 2,	223	0 in 100

indicating that the water was regaining its natural conditions.

It was noticed that case No. 5 obtained water from Lake Pentucket. During the winter months the water of this lake became so low that it was necessary to pump water into it from Kenoza, in order to supply its own district. This practice was continued until January 26, when, on account of the heavy rainfall, the lake regained its natural amount, and from these conditions it seems possible that this case received its infection indirectly from Kenoza Lake water. The danger of pollution of Kenoza Lake under the present conditions must exist as long as the city hospital is allowed to occupy its present position. Recently, however, the water board have obtained control of the hospital, and at the present time a new hospital is being constructed in another part of the city, remote from its water supplies. This building will not be ready for occupancy for nearly a year, and during this interval the present location must be looked upon as a danger to the public health.

Conclusions.

1. That the present epidemic of typhoid fever in Haverhill was due to the pollution of the waters of Kenoza Lake by the overflowing of the cess-pools containing the sewage from the city hospital, and that such conditions still exist, together with a large amount of surface drainage which enters the lake near the intake pipe.

2. That the remedy lies in the adoption of the sewerage system, as recommended by this board on July 7, 1899, and the removal of the city hospital from the water-shed of the lake.

Hinsdale.

The following report of Medical Inspector Morse relates to an epidemic of scarlet fever at Hinsdale: —

On May 4 a letter was received at this office from Mr. L. B. Brague, chairman of the board of health of Hinsdale, containing the information that there were four cases of scarlet fever in the town, and that the family in the house where the cases existed had not properly observed the quarantine regulations of the board. On the same date another letter was received from Mr T. A Frissell, chairman of the school board, conveying much the same information, and that children were staying out of school on account of the presence of the disease in the town.

These letters were answered on the following day, giving advice relating to the quarantining and subsequent fumigation of the houses where cases existed.

Not apparently satisfied with this information, Mr. Frissell sent another letter, dated May 7, in which it was stated that the schools had become almost emptied on account of the presence of the disease, and asked that a visit be made to the town, to assist the local board of health in quieting the fears of the people. It was also stated that some doubt existed as to the correct diagnosis of the disease.

Accordingly I went to Hinsdale on May 9, and visited the houses where cases of the disease had been reported. In all there were ten cases of scarlet fever, which, in my opinion, was the correct diagnosis, although some of them had been spoken of as being cases of measles. The board of health was further advised in regard to the isolation of patients, fumigation of the school where most of the cases had appeared, and the proper fumigation of the houses after recovery had taken place. Formaldehyde was practically unknown to them, and at their request upon my return home I had sent to them a formaldehyde generator, with the necessary amount of formaldehyde to thoroughly fumigate the rooms. Subsequent to that time no new cases of the disease appeared in the town.

Holyoke.

During the past year the board has inaugurated a system of bacteriological examinations in all cases of diphtheria or of suspicious throat trouble.

Such yearly inspections of the bakeries and their surroundings as is prescribed by law have been made. Taken as a whole, these important places, where so much of our food product is manufactured, were found to be in good general condition.

The board is unanimous in the opinion that no sewage should be allowed to enter the river above the dam, and any such plan will be strenuously opposed.

During the year ending Nov. 30, 1900, this city has passed through one of the longest periods of epidemics of a contagious nature that has occurred for a number of years. There have been three epidemics, one each of measles, scarlet fever and diphtheria.

During the year there have been reported 1,056 cases of contagious disease; of these, measles leads the list, with 504 cases.

Leominster.

No better argument for the purity of the water and for the cleanliness of the town could be made than does this fact itself, that, with a population of over twelve thousand, but twelve cases of typhoid fever have been reported in two years, being nearly evenly divided between the two years; and we have reason to believe that nearly every case is reported by the physicians.

The question has been asked, why this board does not insist on a negative culture being obtained in every case of diphtheria before allowing the patient to be released from quarantine. This board has given this subject a greal deal of thought, has looked into its workings carefully, and has talked with the members of the board of health in other places where it has been tried. The result has been, this test has not always been found to be perfectly trustworthy. Some cases have given positive results for four, five and even six weeks after the apparent complete recovery of the patient. Finally, it has become apparent that these cultures, though positive, were not virile, and could not convey the diseases to others. This fact in some cases has caused more or less feeling and trouble, the workingman, dependent upon his daily wages to support his family, chafing because he was obliged to remain in for so long a time, though he felt and seemed apparently well. In the majority of cases, however, this test marks the completion of the disease in the patient, and determines the time when he can safely be released and allowed to go about his daily duties.

This board would recommend that the physicians voluntarily take these cultures, so as to be able, when possible, to release the patient from quarantine with safety to those with whom he comes in contact, which can be done if a negative culture is obtained.

Lexington.

Until otherwise ordered, all persons are prohibited from driving or causing to be driven any diseased cattle within the limits or upon any of the streets of the town of Lexington from other towns or cities, under penalty of arrest.

The board of health adjudges that the exercise of the trade or employment of keeping swine within the limits of the town is a nuisance, and hurtful to the inhabitants thereof and dangerous to the public health. No person, firm or corporation shall engage in or exercise within the limits of the town of Lexington the trade or employment of keeping swine without having first obtained a permit thereof in writing from the board of health, and such permit may be revoked at any time by said board.

The board of health also adjudges that the exercise of the trade or employment of slaughtering cattle, swine, sheep or other animals, or conducting a melting or rendering establishment, is a nuisance, and hurtful to the inhabitants of the town and dangerous to the public health. No person, firm or corporation shall engage in or exercise within the limits of the town of Lexington the trade or employment of slaughtering cattle, swine, sheep or other animals, or of conducting a melting or rendering establishment; but this regulation shall not apply to any person, firm or corporation who may be engaged in such business or employment within the limits of the town of Lexington at the date of the adoption hereof.

Littleton.

The following report of Medical Inspector Morse relates to an epidemic of typhoid fever at Littleton: —

In a communication from Mr. Nelson S. Conant, chairman of the board of health of Littleton, I was informed of the existence of several cases of typhoid fever in that town, and on October 9 I made a visit to the place, and found that three cases of the disease were present in one family and one other case in another, both living in the village proper.

The first patient taken ill was a man fifty-nine years of age, working at North Acton, his occupation being a cooper. On September 16 he was taken ill with the disease, passing through the usual course, and on September 24 two of his sons, aged twenty-six and twenty-four, were taken ill with the same disease. They worked in the suspender factory at Littleton, and neither had been away from home during the incubation period of the disease. The milk supply was obtained from Mr. X., who kept about ten cows and supplied nearly one-half of the families of the town. The absence of any other cases of the disease among his customers is evidence that the milk supplied by him was not the source of the infection.

The water supply of the family was obtained from a well located in the yard some forty feet from the house, and the barn was located about fifty feet from the well, both buildings draining towards it. A sample of water was obtained and analyzed, and found to be polluted to a serious extent. There is a history of a case of typhoid fever occurring in this same house thirty-five years ago.

The other case was a man thirty-eight years of age, who was taken ill on September 27. He worked at West Quincy, and was feeling poorly when he arrived home, but continued to work for a week or ten days before going to bed. The water supply for this house was obtained from a spring on a hill back of the house, and the analysis of the sample obtained at the time of my visit showed the water to be of good quality.

The chairman of the board of health was informed of the results of these analyses, and advised to prevent the further use of the well located at the house where the first cases appeared.

Lowell.

The board of health believes that the erection of a centrally located, permanent building, for the purpose of free baths, is of the first importance to the city of Lowell.

The adoption of the rule requiring one negative culture in all cases of diphtheria before release from quarantine is of very great importance in the effort to check the spread of the disease.

The office records show that during the year two hundred and forty-seven bottles of antitoxin, supplied by the State Board of Health, were issued.

In seventy-nine cases in which the Klebs-Loeffler bacillus was found by culture, and in which antitoxin was used, seventy-six cases recovered and three died, — four per cent. In fifty-nine cases in which the diagnosis of diphtheria was made, and in many of which no culture was taken, in which no antitoxin was used, forty-three cases recovered and sixteen died, — thirty-seven per cent.

There are over one hundred physicians in the city of Lowell, and the very great majority of them are conscientious and painstaking in their efforts to aid their patients towards recovery. Diphtheria requires more than ordinary care and attention, and the health department has in its employ a skilled and willing physician, ready at any time to assist with examination, or in any way, any member of the profession. At any time of the day cultures and antitoxin can be had by application at the office of the board of health free of charge, and the department would entertain the hope that the year 1901 would show even better results than this year, if it was not that the experience of years has brought us to the conclusion that there are some physicians in the city whose services when called for by any family are followed by certain death to the unfortunate victim. To emphasize this proposition, we give the following transcript from the records of this department: —

One physician has had thirty-two cases of diphtheria, and used cultures and antitoxin in every case; result, no deaths.

Another physician has had eight cases of diphtheria, taking no cultures and using no antitoxin; result, seven deaths.

While the mortality from typhoid fever is very low, the number of reported cases is unexpectedly large, when we know that the water supply of the city was entirely free from the introduction, at any time, of Merrimack River water. Quite a number of the reported cases were brought into the city from places where it had been contracted during vacation periods. But there remains a large number that we believe were attacked with the disease by carelessly drinking canal water in the large corporations of the city, where it is always within reach and can be obtained quicker

than the driven well supply, which is not used at all in some of the corporations, although piped across the canals.

This year shows the smallest number of deaths from contagious diseases since 1845, — fifty-five years.

Lynn.

Small-pox Hospital.

The building that was in process of erection at the time of writing the last annual report has been completed, equipped with kitchen furniture, stocked with coal and wood, and is in readiness for the reception and care of this class of patients. An ambulance is ready for their conveyance.

We again call your attention to our former recommendation, viz., "That the city council inquire into the advisability of establishing an abattoir, where those having licenses to slaughter shall kill cattle, calves, sheep, swine and poultry."

Hospital for Contagious Diseases.

The past year, 1900, has been one of great activity at this institution, there having been two hundred and thirty-six patients admitted, with twenty deaths, — a rate of mortality of about 8.5 per cent., a decidedly low rate when considering the character of the cases admitted.

Much work has been done in addition to that done in the hospital, for, of the six hundred and twenty-nine bottles of antitoxin received and used from the State Board of Health, eighty bottles were used outside for immunizing purposes, and eight bottles furnished to physicians; or, in other words, it has been the custom of this institution, when receiving a patient, to immunize the children remaining in the family, if any, as a means of preventing the spread of disease, there having been ninety-nine people so treated by the hospital attendants.

A bacteriological and chemical laboratory has been established the past year, for the purpose of bringing the department more closely in touch with the analysis of milk, and also of giving physicians and the people an opportunity, by scientific means, of knowing when certain diseases exist; and a means by which physicians may know when a warrantable certificate may be given a child to attend school after having diphtheria, or, in other words, a means of knowing when such child ceases to be a source of infection. At present the bacteriologist receives cultures from diphtheria only; but the conception of the laboratory embraced the examination of the blood for malarial and blood diseases, the examination of the sputum for tuberculosis of the lungs, the examination of the urine for kidney and bladder troubles, the use of the Widal test for typhoid fever, and possibly the examination of pathological specimens for diagnosis, — all of which are means looking towards the preservation of the public health, and all of which should be consummated in the near future.

Malden.

A still further measure for the protection of the community from contagious diseases, to which the board strongly leans, is the establishment of a bacteriological laboratory and contagious hospital. An effort to establish by argument the possibilities of beneficent work, if the city were possessed of such a hospital, would be to presume we were speaking to children. This is not the first time that the present board has brought to the attention of our citizens this crying need, and the city's neglect is in strong contrast to the foremost position it takes in some other matters. Instances almost numberless, figuratively speaking, but practically of daily occurrence, come to the attention of the board, where, could the patient be removed from the house and neighborhood, the multiplied instances of infection so common to-day might be almost wholly avoided, and the irreparable loss to the children of the community by the closing of the schools and the practical disorganization of its work would cease to become a necessity.

Marion.

The following report of Medical Inspector Morse relates to an epidemic of typhoid fever at Marion, which was believed to have been caused by the eating of oysters contaminated by sewage : —

On October 23 there was received at this office a communication containing information that there were five cases of typhoid fever in the town of Marion, and asking that an investigation be made by the Board as to the cause of the disease. I accordingly went to Marion on October 25, after interviewing several of the patients who had been removed to Boston after coming down with the disease.

The first patient to be taken ill went to bed on September 22. The milk supply of the family was from Mr. B.; the cream supply from Mr. C.; the drinking water was obtained from the hotel supply, a sample of which was analyzed, but showed no evidence of serious pollution; and the vegetables from Mr. D. Oysters had also been used since the first of September, which were supplied from Mr. M.'s fish market. So far as is known, with but one exception, the patient had not been away from Marion during the summer season. The exception was a trip to Gay Head during the early part of September, and there is no reason to believe, from the description of that excursion, that she contracted the disease while away.

The next patient to be taken ill was a man, thirty-three years of age, who went to bed on October 2. At his house there is a driven artesian well, a sample of the water of which was taken, and did not show evidence of much pollution upon examination. The milk supply was obtained from Mr. K., and the oysters for the house were bought at Mr. M.'s fish market. It was the custom of the patient to be in Boston daily, and perhaps two nights in the week he would remain over night in the city; consequently, it would be difficult to establish the probability of his receiving the infection while at Marion, were it not for the existence and subsequent development of other cases of the disease exposed to the same conditions.

The next patient to be taken ill went to bed on October 9, after feeling poorly for the ten preceding days. The milk supply of his family was obtained from Mr. B., the cream supply from Mr. C., the water from a driven artesian well, the vegetables from Mr. D., the oysters from Mr M.'s fish market, and at times from Mr. O. This patient remained only a portion of the time at Marion, his business calling him to Boston, and at times during the month of September he had visited other cities in the east.

The next patient taken ill with the disease went to bed on October 26. The milk supply for the family was obtained from Mr. S., the water from a driven artesian well on the premises, and the oysters from Mr. M.'s fish market.

Three other patients, one of whom passed part of her time at Newport, R. I., and the other two, who spent only a limited time visiting at the house of one of the patients, were taken ill during the latter part of October. On account of the fact that these three patients all ate oysters while at Marion, together with the evidence that probably the previous cases of the disease had received their infection from oysters gathered under similar conditions, it was not thought necessary to inquire into other possible sources of infection. All of these cases developed among the summer residents of the town, and were immediately removed to Boston, where they were cared for during their illness.

From additional information it was learned that two young men residing at Marion were also taken ill with the disease. The first one was a boy sixteen years of age, who was taken ill on September 22. At his home the water was obtained from a dug well located in the yard, a sample of which was taken, and upon examination showed evidence of pollution, and the milk supply was from their own cow. Although he lived a short distance out of the village, it was his custom to spend most of the time in the town, and it was not unusual for him, during the month of September, to eat raw oysters while he was there.

The other boy, seventeen years of age, was taken ill on September 27. He worked in Hiller Bros. stable, and boarded at Mr. Hiller's house. The milk supply was obtained from Mr. R. and the water supply from a well located near the stable. An examination of the water showed it to be considerably polluted, but to have been subsequently purified by its passage through the ground. Another water supply existed at the stable which was supposed to be used only for the purpose of washing carriages; but, in view of the fact that it had been sometimes used for drinking purposes, a sample was taken, and upon examination showed evidence of considerable pollution. This young man gave up work at the stable a few days before being taken ill, and went to his home in Mattapoisett, where he was sick with the disease; but, on account of the fact that he was at Marion most of the summer, he undoubtedly received his infection while there. It is not known, nor could it be ascertained, that he ate raw oysters at any time.

Although there were some of the patients seriously ill with the disease, all of them subsequently recovered.

Attention having been directed to the oysters as a probable source of infection, a more detailed study was made concerning their origin, bedding and the method of handling them. The oyster supply of the hotel, where no cases of the disease developed, was obtained from Cotuit, and a visit made there showed that the oysters as they were obtained from the shores were not polluted by sewage. Samples of oysters were, however, obtained, and examined at the experiment station at Lawrence, and no colon bacilli were found inside the oyster shell. The oysters

which the patients ill with typhoid fever ate, however, were obtained from a small cove on the opposite side of the Marion shore. Samples were taken and examined, and found free from the colon bacillus. These oysters were subsequently brought to the Marion shore and, when not immediately used were bedded along the shore, usually near Mr. M.'s fish market, in a small cove known as fish market wharf cove. Several families obtaining their oysters from Mr. O. would have them brought to the shore near their own house, bedding them in the water near the shore, and gathering them as they wished them to use. Examination of samples taken from fish market wharf cove and at different places along the shore showed them to be infected with the bacillus coli communis, indicating pollution by fecal matter.

There is no sewerage system in use by the town itself, but the sewage from Tabor Academy — a preparatory school located in the town — is conveyed through a sewer pipe to the bay, and discharged into the water near fish market wharf cove. The sewage of the hotel, which accommodates one hundred and fifty persons, is collected in three cess-pools, from which it is subsequently conveyed through a sewer pipe some five hundred yards into the waters of the bay, and discharged at the flow of the tide. Numerous other private sewers, conveying the sewage from individual houses, are also discharged into the bay, the pipes running out to a point beyond low water. The current of the water of the bay is not particularly strong, and the tendency of the flow is towards the Marion shore rather than towards Little Island, thus bringing the sewage directly on to the shore where the oysters are bedded.

Careful inquiry among the residents of the town did not reveal any previous case of typhoid fever; but it is well known that walking cases of typhoid fever do exist, often so mild as not to require the services of a physician, and it appears perfectly possible that one of these cases may have existed in Marion, and the discharges entered the water in an undisinfected condition.

It is somewhat the custom of the natives, as the town's people are called in contradistinction to summer residents, to withhold any information relating to sickness among their class, with a view to protecting the reputation of the town as a summer resort; and a case of typhoid fever may have existed under these conditions which was concealed by the physician and family, to the evident detriment of those subsequently taken ill with the disease.

As a result of this investigation, it may be concluded that eight of the patients ill with the disease probably received their infection by eating raw oysters, which were bedded in sewage-polluted waters. An examination of oysters obtained under conditions similar to the ones causing the disease showed the presence of the bacillus coli communis, and the following communication was sent to the Marion board of health: —

Dec. 7, 1900.

The Board of Health, Marion, Mass.

Gentlemen: — In compliance with a request received at this office for an investigation in regard to the cause of the prevalence of typhoid fever at Marion, the Board has made such an investigation, and has come to the conclusion that the probable cause of the origin of the disease was the use of oysters taken from sewage-polluted water. The oysters which appear to have been affected were

those principally which came from the cove near the fish market wharf. A sample also taken from the shore near the Hamlin house showed evidence of similar pollution. Quahaugs taken from the cove near the fish market wharf were also found to be infected. It is quite plain, therefore, that the continued use of oysters as food from a polluted region may at any time be attended with danger.

Medford.

Thirty meetings have been held; two hundred and fifty rooms have been disinfected; four hundred and seventy-one permits for school attendance granted; one hundred and forty-seven pedlers licensed; one hundred and thirty-seven nuisances reported, inspected and abated; five hundred and sixty-five inspections made by inspector.

The board has endeavored to maintain a high standard, and, as far as possible, without jeopardizing the welfare of the city, to practise the strictest economy; but our first duty is the protection of the people.

During the last months of 1899 and the first of 1900 we had an epidemic of erysipelas, the number and severity of the cases prompting us to issue cards to the physicians for report of their cases. Twelve physicians responded, fifty-one cases being reported, fourteen proving fatal. The cause or origin of this disease we were unable to discover.

The board has had some difficulty in maintaining as strict a quarantine in some cases as they would like. In large families, where they are confined to a few rooms, it is impossible to secure that complete isolation desirable, and, as we have no hospital or place for quarantine for contagious diseases, with which many other cities are provided, and which we could use to good advantage many times, we have been obliged to send cases to Waltham Hospital, thereby incurring risk to patient and considerable expense to the city.

The question of a medical inspector for our public schools has come to the notice of the board, and, while not prepared to recommend such a step until more definite knowledge of the expense and result of this method in other towns is obtained, the board is of the opinion that some time in the near future such an inspector will be necessary in our city.

Middleborough.

On June 14, 1900, a case of small-pox was reported. The board immediately quarantined the house, and hired two watchmen to prevent any one entering or leaving it.

The board thought it advisable to employ a doctor to take charge of all the patients we might have during the epidemic. On Saturday, June 16, a pest house was built on land owned by John LeBaron, situated on West Grove Street. It was built, furnished and occupied before 8 P.M. of said Saturday, as the board could not find a house suitably isolated to use as a pest house.

After the patients had recovered and been released, the pest house was disinfected with formaldehyde gas and then taken to pieces and washed with solution of corrosive sublimate and the material given to the town highway department, as the board could get no offer for it, and the highway department could use it in constructing sheds.

The board took every precaution to prevent the spread of the disease, and were in position to treat twenty patients, if required. The board requested the scholars to be present at the different public schools in the village on Monday morning, June 18, 1900, and had physicians in attendance to vaccinate free of charge all those who desired to be vaccinated. Over two hundred availed themselves of the privilege.

Milton.

Antitoxin was not used early in either of the fatal cases of diphtheria. During the last six months of the year seven cases of typhoid fever have occurred in East Milton. Almost all of these cases have developed at intervals of about a month, and most of them have been of a very mild type. It has been impossible to trace any source of infection. Repeated analyses have been made of the drinking water and the milk used, without positive evidence of contamination. As the cases have continued to develop, and it was found that all the cases either had taken milk from one milkman or may have taken milk sold by him to another milkman, the discontinuance of the sale of milk from his premises has just been ordered, in the hope that this precaution may be effectual in checking the development of other cases.

Of the cases of diphtheria, seven occurred in four families on Thistle Avenue, all of whom were supplied with milk by one milkman, whose son had previously had a very light attack of nasal diphtheria. As circumstances made it impossible to properly isolate this case, the sale of the milk was stopped. Most of the milk had been sold in Boston, and the Boston board of health was notified, and was unwilling that the milk should be sold there until negative cultures had been obtained.

We cannot say that the large increase in the number of cases of contagious diseases this year is necessarily due to the absence of a general sewerage system, but we would again strongly emphasize the need for the steady increase of the system of sewerage now in use.

Early in the year complaint was made that the sanitary arrangements of a number of school-houses in the town were very defective, and in some cases dangerous to the health of the scholars; so that we deemed it wise to employ an expert sanitary engineer to ascertain the exact sanitary condition of each school-house, and to suggest the changes necessary to put them in a satisfactory condition. This was done, and a written report was sent to the school committee on May 7. The one great need in the perfection of the sanitary condition of the school-houses is the satisfactory disposal of

sewage, as without water-carriage systems it is impossible to keep the sanitaries in perfect condition. Aside from the nauseous odors generated by the burning of effete matter in the school-houses, the great objection to the "dry" systems of sewage disposal is that they depend entirely upon the constant care and attention of the janitor in charge.

The following report of Medical Inspector Morse relates to certain cases of typhoid fever which occurred at Milton in the fall of 1900: —

A few days ago, in a communication from the Milton board of health, I was informed of the existence of several cases of typhoid fever in the town which had existed during the past six months, and a request was made for an investigation as to the probable origin of the disease. These cases were all located in the village of East Milton, and were seven in number, all of whom, it was found, obtained milk from one man. This man's supply was limited to two cows, which he kept in a barn located upon his premises, he doing the milking and the distribution of the milk himself. The water supply in part was obtained from a spring some one hundred yards distant in a field, and a sample taken at the time of my visit was found upon analysis to be polluted. As an additional supply, he collected the rain water from the roof of this house into a cistern, and a sample obtained from this supply was found to be considerably polluted. The fact that no other cases of the disease were present in this part of the town, and that all of the patients obtained their milk from this man, was conclusive evidence of the source of infection, but no history of a case of typhoid fever could be obtained from any of the people living at the farm. From our present information, it must be concluded that the infection was unknowingly introduced into the milk, probably by the use of one or both of the polluted water supplies.

The board of health of the town was informed of this condition, and advised to order the milkman to connect his house with the public water supply, the pipes of which supply were only a short distance from his house. No new cases of the disease followed, and with the adoption of these suggestions it may be assumed that the source of infection was stopped.

Newton.

The general health of the city has been good during the past year, no serious epidemic having occurred during that time. There was a sharp outbreak of diphtheria in Ward 3 soon after the opening of the schools in September, but it was soon under control, and did not cause serious alarm. The deaths from all causes during 1900 were five hundred and two, giving a death rate of 14.94 per thousand, a marked improvement over the previous year.

The subject of daily medical inspection of schools was brought to the attention of the board towards the latter part of the year, and a conference was held between a committee of the Newton Educational Association and the board to discuss the matter. After listening to the proposition, the board expressed itself as unanimously in favor of the plan, provided certain modifications were adopted. The matter was then referred to the

school committee, which body controls the schools, and is at the present time under consideration. The plan contemplates a daily inspection of the schools by a physician with a view to detecting the presence of contagious diseases. It is proposed to divide the city into districts, giving one district to each inspector. It is estimated that the whole cost of applying this system of school inspection to Newton, including salaries of inspectors, printing, etc., would not be more than $2,500 per year, — certainly a small sum to pay out, when we consider the great advantage to be gained in the increased protection from contagious disease, and the diminished interruption of the school work, due to epidemics which cause closing of the schools.

The burning of the scarlet fever ward at the hospital in May compelled the board to reduce the number of cases of that disease sent to the hospital. The city government, after carefully considering the question, decided to replace the old wooden buildings by modern brick structures of increased capacity. These buildings are now in course of construction, one ward and the administration building being promised by the contractor early in 1901. The completed structure will consist of three buildings, an executive building in the centre and a ward building on each side, connected with the executive building by an open corridor. Each building has a general ward at either end, with a central corridor, out of which open the service and private rooms. There is also a suspect room in each ward building, for the reception of suspicious cases. Here the patient will be entirely separated from the other cases, and exposed to no danger from infection, until the disease declares itself.

Formaldehyde is still used by the board for disinfection after contagious diseases, but it has been necessary to discard the old generators which were formerly used. It was found that the later generators purchased for use were less reliable than the original ones, and in many cases when the room was opened the lamp was found extinguished with the greater part of the alcohol unchanged. This occurred so often that it was decided to discard this form of generator and substitute in its place a new form, which, instead of producing gas directly from wood alcohol, regenerated it from commercial formalin, or the forty per cent. watery solution of the gas. These generators are a little more complicated in construction and manipulation than the old ones, but have one advantage over the old form, in that they deliver the gas into the room through the key-hole, accomplishing their work very quickly.

The total number of nuisances and complaints receiving the attention of the board during the year was 2,696, this large number being the result of the house-to-house inspection and the monthly inspection of milk farms.

All farms on which milk is produced for public supply where more than six cows are kept have been inspected each month by the agent, and a report made to the board regarding their condition. Farms where a smaller

number of milch cows are kept have been inspected from time to time. The result of this frequent inspection is shown in the increased cleanliness of the cow barns and the premises adjoining.

The rules forbidding the keeping of swine in cow barns, and requiring frequent removal of manure from the vicinity of such establishments, have been strictly enforced.

Medical inspection of schools: number examined, 13,258; found sick, 5.

North Adams.

The following report of Medical Inspector Morse relates to an epidemic of typhoid fever which occurred at North Adams in September, 1900: —

During the early part of September it was evident from the daily reports of infectious diseases received at this office that there were an unusual number of cases of typhoid fever in the city of North Adams. I accordingly went to North Adams on September 18, to investigate the existing conditions and to discover, if possible, the origin of the cases.

From the cases investigated at that time and from subsequent cases reported it was found that twenty-nine cases of the disease had existed during the month of September, and five others were reported during the first two days of October. Of the first thirty cases reported, it was found that ten of them had milk from one milkman, four had milk from another and five from various other supplies. Of the remaining eleven cases, nine of them were found to have been absent from the city on their vacation, and probably contracted it while away, as the incubation period of the disease corresponded with the time of their absence from the city. One case was a nurse at the North Adams Hospital, who undoubtedly contracted the disease while caring for a patient who was ill with the same disease. Concerning the one remaining case no information could be obtained, as he had since removed from the city.

The larger number of cases, consequently, being on one milkman's route, a visit was paid to his farm, which was located in the village of Greylock, some two miles from the city of North Adams, towards the town of Williamstown. At his home it was found that one of his sons, seventeen years of age, became ill with the disease on August 15. He was cared for at his home and nursed by his mother, who also did the housework of the home, and probably carried the infection indirectly to the milk supply. It was stated that the cans and milk utensils were washed at the farm barn, some distance from the house, and that the mother had nothing to do with this work; but, with a case of the disease existing in the house where other members of the family having direct access to the milk lived, it is probable that the infection was transferred in this way. All of the cases which developed among patients using this milk supply occurred at a time after this boy became ill with the disease.

The milk supply of the four cases using Mr. A.'s milk was further investigated, and a visit was made to his farm at Clarksburg. Here the water supply was obtained from a running stream, and a sample of the water was taken, analyzed, and found to be polluted. No case of typhoid fever was present at the farm, nor could any history of a previous case be obtained.

About this time there was considerable agitation concerning the ice supplied to the inhabitants of the city, it being claimed that the Hygeia Ice Company was selling artificially made ice, which, upon examination, was found to be of questionable purity. It was found, however, that there was no connection between the patients having typhoid fever and this particular ice supply.

The local board of health was informed of the conditions discovered as a result of this investigation, and precautions were taken by the board to prevent the spread of the disease from the milk supplies in question. Its efforts were apparently successful, for during the remaining twenty-nine days of October only nine new cases of the disease were reported. These upon investigation could not all be attributed to any particular source; and, in view of the fact that this city has for the past few years had a somewhat unusual number of typhoid fever cases present, the origin of which could not be determined, we must assume that a source of infection is still present in the city.

Northampton.

The following report of Dr. Morse, medical inspector of the Board, relates to an epidemic of typhoid fever which occurred at Northampton in September, 1900: —

During the month of September, from the daily reports of infectious diseases received at this office, it was evident that an unusual number of cases of typhoid fever had occurred at Northampton, and on November 2 I made a visit to the city, to determine the origin of the disease and to advise the board of health in taking measures to prevent its spread.

Since the 1st of September there had been fifty cases of the disease reported, but on investigation it can be stated that six of them probably received their infection before coming to Northampton. Of these six, one had been to Boston, and was feeling poorly on his return; another was employed at the Mt. Tom Pulp Mill, and was removed to Northampton for treatment; a third had been in West Virginia for two months, and had only recently come to Northampton; a fourth was an actor, who was taken sick in the city while filling an engagement; a fifth had been in Ohio, where typhoid fever was prevalent, and had only been in Northampton two weeks before he was taken ill; and the sixth one came from St. Louis, and was taken ill about one week after arrival.

Of seven other cases, no direct history of infection can be obtained with the exception of one case, where a man twenty-seven years of age was taken sick on September 17. He had recently reopened a well, located on the premises, which had been closed for fifteen years previous, and a sample of this water upon analysis showed considerable pollution.

Of the thirty-seven remaining cases, all of them can be traced to the drinking of a spring water which was polluted by the sewage of the Dickinson City Hospital. This spring is located upon the hospital hill, about a hundred yards distant from the building, and the water is first collected into a brick cistern. It is then further conveyed about a hundred yards through an earthen pipe into a barrel, which also receives a certain amount of the natural drainage of this water-shed. An analysis of a sample taken from the brick cistern shows a water of comparatively good quality, but a sample obtained from the barrel lower down shows that at

some intermediate point pollution has entered the water. From this barrel the water is still further conveyed a distance of some four hundred yards to Bailey's brick-yard, where some years ago it was used for manufacturing purposes. The method of conveying the water is through a wooden pipe, and at several places there is evidence that the pipe has decayed and has been repaired by making connections with iron pipes. The outlet at the brick-yard is the terminus of this wooden pipe.

The sewage from the hospital is conveyed a distance of some three hundred yards in the direction of this spring, and then, apparently by a break in the pipe, comes to the surface and flows superficially into a brook near by, which eventually enters Mill River. The point at which this sewage comes to the ground is almost in a line with the wooden pipe which conveys the spring water from the barrel to the brick-yard, and on examination the surface of the ground covering this water pipe was seen to be saturated with sewage. The water from this spring as obtained at the brick-yard was not usually used for drinking purposes, but during the past dry season, on account of an unpleasant odor and taste in the city's public water supply, several families living in the vicinity of this brick-yard used the water for drinking purposes. At that time they did not notice any unpleasant odor or taste to this spring water, but subsequently it did have a marked odor of carbolic acid, and upon investigation by the local board of health it was found to be probably polluted by the sewage from the city hospital entering the pipe at or near the point where the sewage comes to the surface of the ground. An analysis of a sample of water obtained at the outlet of the spring water pipe at the brick-yard shows that it has received a large amount of sewage since its leaving the barrel located higher up on the course, and undoubtedly this pollution comes from the sewage of the hospital. This spring water supply was further used as the drinking water supply of the employees working in the lower cutlery mill near by. The water was carried in pails and distributed around the building for the use of the employees, and many of them subsequently became ill with the disease. The local board of health, about the middle of October, having discovered this probable source of infection, placed a written notice upon the ground near the outlet of the pipe, warning people that it was not safe to use this water for drinking purposes. With the prevention of this source of water supply the cases diminished in number immediately.

The board of health were later notified of the conditions discovered as the result of this investigation, and the following communication was sent to them, advising them to prevent the further use of this supply in a more efficient manner than by the posting of a notice at the outlet of the pipe: —

OFFICE OF STATE BOARD OF HEALTH, STATE HOUSE,
BOSTON, Jan. 11, 1901.

To the Chairman, Board of Health, Northampton, Mass.

DEAR SIR: — From the daily reports of infectious diseases received at this office from Northampton during the month of October, it was evident that an unusual number of cases of typhoid fever were present in the city, and an investigation as to their origin has been made by this Board, in which it was assisted by your local board. As a result of the investigation, it was found that fifty cases of typhoid fever had appeared in Northampton since September 1. Of these cases, six undoubtedly received their infection before coming to the city, and some of these

were taken to the Dickinson Hospital for treatment. In seven of the remaining cases no history of common infection can be obtained, and the probable source of infection in these cases has not been determined. Thirty-seven cases, however, can be traced to the use for drinking of a spring water which had been polluted by the sewage of the Dickinson Hospital. The spring from which the water was obtained is located upon the hill near the hospital, about three hundred feet from the building, where the water is collected in a cistern, from which it flows through an earthen pipe to a barrel, and thence in a wooden pipe, repaired in places by iron pipe, to the brick-yard, a little over a quarter of a mile distant.

An analysis of a sample of water collected from the spring on the hill shows that it has at some time been considerably polluted by sewage, and there is evidence that it has not been wholly purified before reaching the spring. Comparing the analysis of the water collected from the spring with the analysis of a sample of water from the outlet of the pipe at the brick-yard, it is evident that the water receives further pollution in its flow from the spring to the brick-yard. The sewage of the hospital is discharged into a pipe leading down the hill, which evidently terminates or is broken in such a manner that sewage escapes from it in the neighborhood of the water pipe; and, since but little water was flowing through the pipe during the past fall, and the pipe was not full, it is probable that some of the sewage found its way into the water pipe in an unpurified state.

The Board would advise that the further use of the water from the spring or the pipe in question at any place be effectually prevented, and that a proper means for the disposal of all the sewage of the hospital be provided without delay.

In the course of the investigations made by the Board a sample of water was collected from a spring of E. C. Southwick, near Elm Street, which appears to have been used as a source of drinking water, and was found upon examination to be highly polluted by sewage, as was also a well at 74 Mill Street, where cases of typhoid fever occurred. The Board would advise that the further use of these sources of water supply be prevented.

Norwood.

In other years we have pointed out some of the dangers of using wells for water supplies for domestic purposes. These dangers will not lessen, but increase, as time goes on, and we advise the discontinuance of the use of all wells in the thickly settled portions of the town.

In the course of our work, with its opportunities for making observations, we became convinced that the citizens of this town should move at once in the matter of providing the town with a public sewer system. We believe that it was not only proper, but incumbent on us, because of the function of our office, to set in motion the movement which we trust shall at no distant day provide this town with such a system.

The following reports of Medical Inspector Morse relate to the epidemics of typhoid fever which occurred at Norwood in the winter and summer of 1900: —

On January 1 a letter was received from Mr. Lyman F. Bigelow, secretary of the Norwood board of health, containing the information that five cases of typhoid

fever had been reported during the past month, and that they desired an investigation in regard to the cause of the disease. I accordingly went to Norwood the following day, obtained a list of the cases reported, and personally made a visit to each one to determine the common source of their sickness. Another case had been learned of after my arrival, making six cases in all.

The usual inquiries were made in regard to occupation, their absence from the town at one time or another, their milk supply, etc.; and after the visits had been completed it was found that all of them had taken milk from one dealer, Mr. A. Five of the cases lived at Norwood and the other at East Walpole, a part of which town Mr. A. also supplied with milk.

The milk being the probable manner by which the disease was propagated, a visit was made to the dealer, and the existing conditions further investigated. He bought all of his milk from seventeen different farms, situated in Norwood and Walpole, and the conditions at the house and the method of caring for the milk were as follows. The milk was collected daily in the morning from all of the farms, and brought to Mr. A.'s milk shed at Norwood. The amount, approximately one hundred cans, was mixed in a large mixer, and then a portion of it was put into bottles for distribution to the customers, and the remainder was placed in eight-quart cans for other customers. All of it was then placed in the ice chest, to remain until next morning, when it was distributed by two teams to the families supplied by him. Inquiry was then made in reference to which team supplied the families where the disease existed, with the possibility of finding all of the cases on the route of a single team, but it was found otherwise, for four cases had milk from the team driven by Mr. B., one of the employees, and the other two from the team driven by Mr. A. himself. Inquiry was then made in reference to the help about the milk shed. Mr. A. and three men handled all of the milk, and with but one exception the hired men had been working for him for a period of nearly a year, the exception being a young man, twenty years of age, who came to work here on December 6, a date too late for him to have any connection in causing the first three cases. None of the men had complained of any sickness whatsoever, in fact, all of them had worked daily; neither had they had any attack of diarrhœa at any time. All of the cans and bottles were said to be thoroughly washed and scalded out at the milk shed, the water being obtained from the public water supply of Norwood.

The infection not apparently existing at the milk shed, a further study was made by visiting the seventeen different farms from which he obtained his milk. At one farm it was learned that a case of typhoid fever existed seven years ago, and at another there were two cases of the disease three years ago, and at still another two cases had appeared three years and nineteen years ago. Careful inquiry was also made in regard to any of the help about the farms having any questionable illness recently, but with negative results, and apparently no visible cause could be found. It was, however, decided, as a result of the investigation up to the present time, to revisit the milkman, explain the situation to him, and inform him that for a period of two weeks he must not mix his milk; and, furthermore, that he must give the same farmer's milk to the same family each successive morning during this time. He offered many objections before complying with this request, but finally he acceded to it, and this practice was commenced on the morning of January 4.

The next cases to appear were on the 8th and 10th of the month, a time too

early to be of value in determining from which farm the probable infection came, and, as each received their supply from a different farm, they probably received the infection from the mixed milk rather than from the separated milk.

The next two cases, however, were of great importance in indicating the probable source of the disease. Both were taken ill on January 14, and both had unmixed milk from the same farm. A second visit was accordingly made to this farm, and the conditions more carefully investigated. It was found on inquiry that the owner himself had appendicitis three years ago, and it is possible that infection may have taken place from this source. A sample was taken from the well from which water was used for washing the milk pans and strainer, analyzed and found to be polluted. The Norwood board of health were notified of these conclusions, and advised immediately to take measures to prevent the further use of the water of this well, and to have the different utensils used in handling the milk at this farm thoroughly sterilized, and up to February 16 no new cases have developed.

On July 27 my attention was again called to a large number of cases of typhoid fever appearing in the town of Norwood, and which were being reported daily to this Board. I accordingly made a visit to the town, for the purpose of ascertaining the origin of the disease and advising the local board of health in taking measures regarding its spread.

The first case which had been reported was a man fifty years of age, a machinist by trade, who was taken ill on June 19. He had visited New York during the early part of the month, and the prodromal symptoms of the disease were present when he returned. In all probability he contracted the disease while away on this visit.

He obtained his milk supply at Norwood, from Sunnyside Farm, and the public water supply from Buckmaster Pond was in use at the house in which he lived.

No other cases developed until July 10, when a young man twenty-six years of age, working in the tannery, was taken ill. He obtained his milk supply from Mr. A. and at times from Mr. B.

During the following seventeen days twelve other cases of the disease were reported, and upon personal investigation it was found that all of them had taken milk from Mr. A., and some of them in addition had other milk supplies, which were not the same in all of the cases.

Among the early patients was one of the men who worked for Mr. A., who assisted in collecting and distributing the milk. He went to bed on July 14, although he had been feeling ill for a few preceding days. It was his custom, on account of the fact that he collected milk over a certain route, to use one man's milk at his own home, the milk being obtained from the farm of Mr. C., in East Walpole.

In the early part of January of this year there had appeared ten cases of typhoid fever in the towns of Norwood and East Walpole, and upon investigation it was found that all of these cases had access to this same milkman's milk, and it was finally concluded that the original infection was from Mr. C.'s farm in East Walpole. With this information, attention was immediately turned to this farm again. As a result of the previous investigation, the board of health of Norwood had instructed Mr. C. that none of his milk could be distributed in the town until he had obtained a new water supply which should be of a pure character.

Both he and Mr. A., to whom he sold his milk, were informed of this decision, and for a time it is presumed that they followed instructions. Later, however, their business relations were resumed unknown to the board of health, and Mr. C.'s milk was distributed through the town.

As the investigation of the epidemic continued, the above facts were ascertained, and on August 3, as many more cases of the disease were being reported, the board of health issued strict orders to Mr. A., prohibiting him from buying milk from Mr. C., and prohibiting Mr. C. from selling any of his milk in the town of Norwood.

From the appearance of the epidemic on July 10 to the end of the month twenty-one cases of the disease were reported, all of whom had Mr. A.'s milk; and during the first thirteen days of August twenty-four more cases appeared, all under the same conditions. With the instructions of the local board of health to the milkmen on August 3 the source of the infection was removed, for after the 13th of August only one more case of the disease appeared, that one being reported on the 27th of the month, and during September one case was reported from the same town.

It is not known that these later cases received their infection from the same source as those preceding them, as no direct information could be obtained that they used Mr. C.'s milk.

The source of infection at Mr. C.'s farm was traced to the well water used in washing the cans and utensils at the house, and this well was found considerably polluted by an analysis of the water made during the January epidemic. At that time the water of the well was quite low; but, with the coming of spring and an increased rainfall, the well furnished sufficient water until the summer months, when the water was again low and at times the well was dry; in fact, when I made my visit there it was stated that there was no water in the well, and that they procured their supply from Trap-hole Brook, a stream close by. I was, however, able to obtain water from the well.

Mr. C. was further informed at this time that none of his milk could be sold in the town of Norwood under any conditions until he had obtained a new water supply. Accordingly, at the request of the local board of health, an analysis of the water of Trap-hole Brook was made, and it was found to be apparently unpolluted. With this as a new water supply it was possible for Mr. C. to resume selling milk in the town, since which time no new cases of the disease have developed.

A peculiar development in the course of this investigation was the fact that several persons employed in the book bindery contracted the disease. Most of these people at their homes did not take milk from Mr. A., but it was the custom at the book bindery for them to have left for their use a limited amount of milk, which was obtained from Mr. A. These cases began to develop on July 26, not quite two weeks after the milkman employed by Mr. A. was taken ill. It is apparent, from the subsequent cases that developed, that these cases received their infection from milk which was handled by the milkman in question; and consequently there were two sources of infection,— the original milk from Mr C.'s farm, and the mixed milk which had been handled by the milkman subsequently taken ill with the disease. With his going to bed, however, this source of infection was removed, but other cases developed which could not have obtained their infection from milk which he handled.

The conditions existing at Mr. A.'s barn had not been improved since the investigations of last January, and the board of health gave him instructions to improve his facilities for handling milk.

Pittsfield.

At the termination of each case of scarlet fever and diphtheria the premises have been fumigated by the use of the formaldehyde gas generator, and during the year all the principal school-houses have been fumigated by the same process, some of them several times. Many persons, among them people of intelligence, manifest a disposition to disregard the quarantine regulations relating to contagious diseases, and thus show that they have little or no concern for the welfare of other people in the community. A cheerful co-operation by the public with the board of health is necessary to obtain satisfactory results. The physicians of the city have been very vigilant in their efforts to prevent the spread of contagious diseases, and thereby render the board valuable assistance.

Plymouth.

Thirty-three complaints have been made and investigated by the board this year, and such remedies applied to the faulty conditions as were practicable. In ten instances it was found necessary to require owners to connect their property with the sewer provided by the town, instead of using primitive and defective methods of disposing of their sewage. These requirements of the board have all been met. In one instance property was found, upon investigation, to be in such an unsanitary condition that it was ordered abandoned until it could be rendered suitable for habitation in the opinion of the board.

Analyses of the water of Elder Brewster Spring have been made from time to time, as advised by the State Board, and it has been found uniformly potable.

The desirability of having some sort of isolation hospital ready in case of emergency is impressed upon us at present by the prevalence of small-pox in towns at no great distance from us. It is obviously unwise to wait until the necessity arises, and then hurriedly construct a building which is inadequate, the time when it would have been useful very likely having passed before it is completed. The first cases of small-pox occurring in a community are generally among transients who are living in public houses or other quarters where isolation would be impossible ; but, even with every advantage in the way of isolation, any case in the midst of a community is a menace to that community.

Quincy.

It is the opinion of this board that the adoption of a system of medical examination of school children would result in the decrease of contagious

diseases among our school population, as the school offers most favorable conditions to contagion, and we earnestly recommend an appropriation to that end.

Reading.

The following report of Medical Inspector Morse relates to an outbreak of scarlet fever which occurred at Reading in the winter of 1899–1900: —

On January 17 a letter was received at this office from Mr. A. of Brookline, calling attention to a large number of cases of scarlet fever at Reading, and the alleged laxity of the local board of health in dealing with the cases. He also said that he was interested on account of relatives in the town, their boy having the disease at the present time. As a result of a visit, I found that thirty-three cases of scarlet fever had existed since Oct. 30, 1899, and these cases had been divided among twenty-one families. With but seven exceptions, all were among children attending school or those too young to go to school. The first case appeared on October 30, in a male twenty-six years of age, living in Reading and going to Boston daily to work. In view of the fact that it had been many months since a case had existed in Reading, it is fair to assume that he contracted the disease while away from there. The next cases to appear were two children, two and four years of age, living in an entirely different part of the town, who were taken ill November 21. The exact origin of this infection cannot be stated, as they had not knowingly come in contact with anybody having the disease; but they were the source of three other cases appearing on December 20, the infection being carried by means of the washerwoman who did work for both families. The next case appeared on November 22, and was the case referred to in Mr. A.'s letter. The boy was six years of age, and attended school, but the origin of his illness is not evident, he being one of the first cases to contract the disease.

No other cases developed until December 20, and from that date until the end of the month fourteen cases were reported; and during January, up to the 15th of the month, fifteen more cases were present, most of them being located in the east part of the town, and the children for the most part attending two schools. On inquiry of the board of health I found that the houses were properly quarantined, and when desquamation was complete the houses were fumigated with formaldehyde in an efficacious manner, the attending physician notifying the board when the process was finished. In view of the fact that attending physicians do sometimes report a case as "well" when desquamation is still in process, I advised the chairman to personally visit every case so reported, in order to determine for himself whether the patient had passed the infectious stage or not, and not to fumigate the house until all danger of spreading the disease was over. In addition, I also advised temporarily closing the two schools where most of the cases had originated until they had been fumigated with formaldehyde.

The results obtained, I believe, show that these precautions were successful in stopping the course of the disease; for no other cases developed until the 30th of January, when two cases were reported, and only one case has appeared up to February 15.

Salem.

Hospital for Contagious Diseases.

The large number of cases of diphtheria, which have not been so numerous since 1896–97, together with scarlet fever, emphasizes the necessity for provision being made in this direction. It is quite clear that with a good hospital, especially for diphtheria, much of the spread of these diseases can be prevented, and both expense and hardship saved. Two important things would be greatly improved, — people would not be so seriously interrupted about their work, and children would be permitted to go back sooner to school.

Somerville.

Number of nuisances abated,	920
Number of nuisances referred to board of 1901,	85
Number of nuisances complained of,	1,005

In addition to the above, 187 dead animals have been removed from the public streets, and many nuisances have been abated on verbal notice from the agent, without action by the board, of which no record has been made. The number of loads of ashes collected were 27,346; house offal, 5,958 loads.

Recognizing the superior advantages to the community of an unrestricted and general supply of culture tubes easy of access to physicians called to cases of suspected diphtheria, the board arranged in the latter part of the year to supply its own culture outfit boxes, and distributed them from half a dozen pharmacies in different sections of the city. Sputum bottles, also, for suspected tuberculosis, have been obtainable at the same stations. Since more prompt and daily reports upon cultures from cases of suspected diphtheria were found to be necessary, the board established a bacteriological laboratory.

A system of daily medical inspection of the public schools by qualified physicians would exclude from our school-rooms some mild cases of diphtheria and other infectious diseases, for not infrequently persons so infected are able to attend school. It is hoped that the coming year the inspection may be made in this city, as it is strongly recommended by this board.

The large number of cases among domestics in families and persons in lodging-houses and tenements, with no means of isolation, clearly demonstrated the need, for the protection of the city, of a hospital for persons sick with contagious disease.

Southbridge.

During the year a recommendation was made to local boards of health by the State Board, urging the importance of vaccination for the people, because of the beginning of an epidemic of small-pox in Fall River, New

Bedford and other mill towns. Your board, believing it to be a wise measure, accordingly provided the people with vaccination at considerable expense to the town; over 1,200 people availed themselves of the opportunity thus offered.

Swampscott.

The collection of ashes and rubbish is, we believe, a long step in the right direction, appreciated by the people of the town, and should be continued.

The beaches have been cleaned from time to time, and the fact that we have not received any complaints leads us to believe that they have given satisfaction to the people of the town and summer residents.

Wakefield.

The board of health inspected the high school building, and found serious defects in the plumbing. The objectionable system of drying by fire, or otherwise treating the sewage and excreta of the school in the basement of the building, was severely criticised by the board.

Waltham.

The city has been very free from all infectious diseases, with the exception of diphtheria. That disease has been prevalent throughout the year, but with the opening of the schools in September an epidemic began, which spread over nearly all sections of the city. Although all the usual methods to check its spread were adopted, the disease continued to increase, until in November there were nearly fifty cases at one time, and several new cases were being reported daily.

At that time four school inspectors were appointed, and a thorough inspection of all the schools was made. The throat of each school child in the city was examined, and cultures taken of all suspicious cases. In this way twenty-two pupils who were suffering from mild diphtheria were found attending the various schools. All had the diphtheria bacillus in the nose or throat, and were therefore capable of communicating the contagion to others. These children were isolated and kept in quarantine until cultures showed them to be free from infection. The effect of this procedure upon the spread of the epidemic was soon apparent, and before the Christmas vacation the number of new cases was comparatively small.

Pediculosis.

The prevalence of this disease in the schools was recognized last year, and some effort was made to get the worst cases disinfected. This year a systematic effort has been made to get rid of it. The school inspectors have examined all the pupils in several schools. In one school forty-three per cent. of the pupils were infected, thirty-nine per cent. in another, and in every school many cases have been found. The percentage of infection was greatest in the primary schools and lower grammar grades.

The following report of Medical Inspector Morse relates to certain cases of typhoid fever which occurred at Waltham in November, 1900: —

During the latter part of November and the early part of December seven cases of typhoid fever were reported to the board of health of Waltham, and in a communication from them it was ascertained that they desired an investigation as to the origin of the disease. As a result of this investigation, it has been found that these cases have all appeared among people using the milk supply of one man. Upon tracing back this supply, it was found that at a farm house where milk was obtained which was supplied to these customers there had been a case of typhoid fever last August. This case had never been reported to the Waltham board of health, and up to the present time no information had been obtained concerning it. The patient's discharges at the time of her illness went into the cess-pool located on the grounds, and about five weeks ago this cess-pool was cleaned for the first time since her illness, and the contents distributed on the ground immediately surrounding it. The same man who cleaned the cess-pool milked the cows, and it seems probable that some of the infection must have been transferred to the milk by him.

A fact of somewhat equal importance was discovered when it was learned that this farm was located near the Hobbs Brook reservoir of the Cambridge water supply, and that the contents of the cess-pool when dipped out upon the ground flowed into a brook which eventually entered the Stony Brook reservoir of the same system. The danger of the pollution of the Cambridge water supply was therefore apparent, and in the following communication the water commissioners of the city of Cambridge were notified of the existing danger.

Following the discovery of the probable origin of the cases of the disease in Waltham, measures were taken to prevent its further spread, and these measures proved successful.

Dec. 11, 1900.

Mr. Wm. B. Durant, *President, Cambridge Water Board, Cambridge.*

Dear Sir: — The attention of this board has been recently called to a limited number of cases of typhoid fever existing in Waltham. As a result of an investigation, it was found that these cases probably received their infection from milk which was obtained from a farm where a case of typhoid fever existed last summer. The farm in question is that of Mr. A., located near the Hobbs Brook reservoir of your public water supply.

Mrs. A. was ill with typhoid fever last August. The case was never reported to the Waltham board of health, and consequently no information was ever obtained concerning the case up to the present time. About five weeks ago the cess-pool of the house into which her discharges had gone during her illness was cleaned by one of the hired men, and the contents deposited on the ground about the cess-pool. From its location, it is evident that the natural drainage of this land is towards Stony Brook reservoir, and consequently is a source of pollution to your water supply. This condition has only recently been ascertained, and I have communicated it to you thinking that you were not aware of the existing condition.

Watertown.

For the ordinary needs of the town for hospital purposes, we being as yet too small a community to be able to support for ourselves a general

hospital with all the first-class facilities reasonably called for in these days, it would seem most expedient for the town to secure for itself at least one free bed in the hospitals of two or more of our three neighbors, Cambridge, Newton and Waltham. We should then be always reasonably sure of being able to gain convenient entrance for any patient into one of them. Arrangements might also be made with some competent person for doing the needful bacteriological laboratory work for the town, that more speedy returns may be had upon cultures submitted.

School Inspection.

Although we have been thus far remarkably free from the contagious diseases of our neighbors, we can reasonably expect to continue so only upon the condition of our observing all due sanitary precautions. Prominent among them, in these later days, is a regular system of inspection of all cases of illness arising among the children while in attendance at school.

Wellesley.

The town is fortunate in having passed through the year with so few cases of diphtheria, when the experience of neighboring communities is recalled.

The use of formaldehyde gas has many points in its favor, and has practically superseded all former methods of disinfection.

A supply station has been established, where culture tubes, antitoxin and sputum cups may be had at all times free of cost, the only requirement being a report of the use thereof to the State Board of Health.

The statute, usually more or less neglected, requiring vaccination of pupils attending the public schools, has, with the assistance of the superintendent of schools, been fully complied with during the past year.

Westborough.

The following report of Medical Inspector Morse relates to certain cases of typhoid fever which occurred at the Westborough Insane Hospital in September and October, 1900: —

During the early part of October a communication was received from Dr. A. of Westborough, containing information of the presence of several cases of typhoid fever at the Westborough Insane Hospital, and asking that an investigation be made as to the origin of the disease.

On October 11 I made a visit to the town, and found that eight cases of the disease had appeared at the Insane Hospital, the first one appearing on September 7 and the last one on October 4. Six of them had been among the employees of the hospital and the other two were inmates of the institution.

The milk supply, for the most part, was obtained from the farm connected with the hospital, but during the previous two months one hundred quarts of extra milk had been obtained from D. & Co. daily. From an investigation of the cases,

however, it can be inferred that the milk was not the source of infection. The water supply was obtained directly from Lake Chauncey, situated near the hospital. The hospital had originally two distinct water supplies, one being taken directly from the lake, and intended only for domestic purposes; the other a series of driven wells located near the shore of the pond, and to be used for drinking purposes. About a year ago, however, the latter supply was abandoned on account of the presence of iron in the water, which made it objectionable for drinking purposes, and since that time the water from the lake has been used for both purposes at all times.

The Lyman School for Boys is located on the opposite bank of the lake, some of the buildings of the institution being upon the water-shed, and Lyman Hall, one of the largest buildings of this school, discharges its sewage, for the most part unpurified, into a brook, which later flows into Chauncey Lake. The system of sewage as originally planned was to purify the sewage by collecting it in cesspools located upon different parts of the grounds, then, by subsoil purification, eliminate the larger part of the impurities. On account of the character of the soil, however, this system has not been in successful operation, and considerable quantities of crude sewage were seen to come up through the ground, flow along its surface and eventually enter the afore-mentioned brook. A sample of the water of this brook, taken at a point just below the Lyman School, was obtained and upon analysis found to be badly polluted. Just at the entrance of the brook to Chauncey Lake another sample was obtained which was found upon analysis to be less polluted, probably by its dilution with water obtained lower down in the course of the brook. With the abandonment of the tubular well system, as mentioned above, the hospital authorities attempted the filtration of the Chauncey Lake water intended for drinking purposes. The water was passed through five feet of sand and then pumped to a tank in the tower, from which it was distributed to the buildings. This water was supposed to be used in all cases for drinking purposes, and during the summer season water tanks were placed in all of the wards to be filled with this particular supply. On the other hand, the water pumped directly from Chauncey Pond, unfiltered, was available in the kitchens and bath-rooms of the different buildings, and some of the employees who were taken ill with the disease admitted drinking this unfiltered water at different times.

With the appearance of these cases of typhoid fever, the superintendent of the hospital, to protect the inmates and employees from the disease, had the water passed through a boiler to sterilize it before it was available for drinking purposes. From a chemical and bacteriological examination of samples obtained both before and after boiling and filtration, it is evident that this process did not properly prepare the water to make it safe for drinking purposes. No colon bacilli, however, were found in any of the samples examined.

An additional source of pollution to the water of the lake is the presence of several summer cottages located upon its shores and a large picnic ground located on the easterly side of the lake. This latter attraction may prove to be one of considerable objection, as a street railway has been recently built upon the line, and it is the intention of the railway company to still further enlarge the accommodations at this ground.

The ice supply of the town is obtained from this pond, and two other large ice houses are filled with ice during the winter season, which is later sent to Boston for use. These houses are located even nearer the outlet of the sewage-polluted

brook which flows into the pond than is the intake pipe of the hospital water system.

The board of health of the town of Westborough and the hospital authorities were notified of the danger of using this water for domestic purposes, and advised to take measures to further protect themselves from the dangers existing by using this water.

Westport.

The following report of Medical Inspector Morse relates to an outbreak of small-pox which occurred at Westport, Fall River and other places in the spring and early summer of 1900: —

During the month of April and the five following months there appeared in the city of Fall River and in the towns of Westport, Dartmouth and Middleborough a large number of cases of small-pox. These were duly reported to this Board, but it was not until the early part of June, when the disease appeared in the town of Westport, that my personal attention was directed to the cases. I accordingly began an investigation of these cases at that time, and found that the first case which was under medical supervision at Fall River appeared on April 21. From a further history it was learned that a French family by the name of O. came to Fall River from Rimouski, Quebec, where small-pox was prevalent, during the month of March. From subsequent developments it was learned that the father of the family and probably three sons became ill with the disease. It was apparently of such a mild character that they at no time required the services of a physician to treat them; in fact, most of the time they were up and about the streets of the city. With the appearance of this case in the latter part of April the board of health instituted strict quarantine measures, in order to limit the spread of the disease. They were successful to a certain extent, but, on account of the mild character of the disease, a number of cases undoubtedly existed in the city about which no information was ever obtained. The locality affected was the part of the city known as Flint Village.

On the first day of May and during the week other cases of the disease appeared, and on May 10 the small-pox hospital was opened, to which place all subsequent cases were taken. During the month of May eight cases of the disease were reported, but it was not considered that it had gained much headway, the cases being for the most part discovered after strict search by the local board of health. On May 28, however, a wedding occurred in a French family living at 262 Jenks Street. It is estimated that some two hundred people attended this wedding, and among them was one of the O. boys, who had the eruption of the disease well marked upon him at the time, but who was not sufficiently ill to require medical attendance. This exposure of a large number of people seemed to propagate the disease more rapidly, and during the month of June twelve new cases were found, all of which were removed to the hospital. The disease still continued to spread, but to a limited extent, and during the month of July four cases were reported and one each in the months of August and September. Of the number taken ill, one, a child of four months, died, the disease being complicated with pneumonia.

With the appearance of the disease in Fall River it was an easy matter for it to invade the town of Westport, situated some few miles away. The contagion was

carried by a man of the same name as the original case at Fall River, who came to Westport looking for work. He finally found some outdoor labor, and boarded with a French family by the name of L. At the time of his coming to Westport it is stated that the eruption was present upon him, but, as he was able to work daily, it was not thought to be the eruption of small-pox. The first one of the L. family to be taken ill showed symptoms of the disease on June 5, with the characteristic eruption; and during the remainder of the month fourteen cases of small-pox appeared among those who had been exposed to the original infection. The board of health at first wished the Fall River board of health to care for their patients, but no satisfactory arrangement could be made, and they accordingly, instituted a contagious hospital for their own use in an old-fashioned, unused farmhouse, some quarter of a mile distant from the road, and reached by a cart path from the main highway. All patients were transferred to this hospital, and other persons exposed to the disease were isolated in another house, over which the board of health obtained control. Two other cases appeared during the early part of July, which apparently ended that epidemic.

On June 15 the board of health of Middleborough reported that a case of small-pox existed in that town. I immediately went there, and found the patient to be a man forty-five years of age, who worked in the iron foundry. He was taken ill on June 7 with the prodromal symptoms of the disease, and on the 12th the eruption appeared. This was the only case that was reported to the board of health at the time, but upon looking over the different members of the family in the house where this case existed, it was found that two school children also had the beginning eruption of the disease out upon them. These children, it was further learned, had attended school the day previous, although they were known to have been somewhat ill. There were ten people living in this house, five of them being laborers upon the new railroad bridge which was then in process of construction. The board of health were advised to immediately procure a building for the isolation of these cases, and they at once made an effort to do so, but could not obtain a suitable building at a reasonable cost. They accordingly built a hospital and had the patients removed to it within twenty-four hours, the location of the hospital being remote from other inhabited buildings. All of the persons living in the house were vaccinated, also the school children at the building where the two children attended school, and considerable general vaccination was done throughout the town. No further cases developed, and these three patients ultimately recovered.

One case of the disease occurred in the town of Dartmouth, but the advice of the board was not asked for, relative to the quarantine measures to be adopted. The origin of this case is not definitely known, and in all probability the infection was received from one of the Westport cases, as the patient lived on the opposite side of the street from those ill with the disease.

The origin of the Middleborough cases could be definitely traced to one of the original O. family at Fall River, as he was able to be up and around most of the time while ill with the disease, and went to Middleborough looking for employment. On June 2 he appeared at the house where the cases subsequently developed, the eruption still being present upon his body, and obtained his dinner here. He later went with Mr. M., the patient subsequently taken ill with the disease, to the iron foundry, but was unable to obtain employment there, and there was some evidence that he later obtained work chopping wood a short dis-

tance from the town, but the information was indefinite, and on further investigation could not be corroborated.

On July 6 a case of the disease was reported by the board of health of the town of Attleborough, and I immediately went to the town to examine the patient. He was a man thirty-two years of age, living in the middle of the town, and working in A.'s jewelry factory. Some ten days previous to being ill he went to Rocky Point, R. I., on a pleasure trip, and, although it is not known that he was exposed to one having the disease, it is probable that he received his infection at that time. The diagnosis of this case was somewhat complicated by the appearance of a typical case of chicken-pox in a child in the other side of the house; and the patient was also seen by Dr. Swarts, secretary of the Rhode Island board of health, and by Dr. Chapin of the Providence board of health.

On June 23, at the request of the New Bedford board of health, which stated that they had some unusual cases of a peculiar skin disease, upon which no definite information could be obtained from the attending physicians, I went to the city to make a study of the cases. At that time the disease existed in three different houses, located in what is known as the "West End" of the city, the first patients becoming ill being in the L. V. family, living on Philips Avenue. The baby, a child about one year of age, was the first one to be taken ill, and about two weeks later another child, two years of age, was also taken ill with the same eruption. Still two weeks later, the father, employed in one of the mills, was taken ill with the disease, and at the time of my visit the eruption was apparently at its height. In the case of the first child the eruption had entirely disappeared, and all that was left was a profuse pigmentation of the skin at the sites of the eruption. The second child had passed through the acute stages of the disease, and the eruption was in the crust stage. These crusts could be easily loosened by the finger nail, and upon removal left no abraded surface or any pit mark which would indicate a characteristic case of small-pox. It did, however, leave considerable pigmentation upon removal of the crust. In the father's case the eruption was in the pustular stage, and pustules as large as the tip of the little finger, raised a quarter of an inch from the surface of the skin, were present all over the body. The temperature was somewhat elevated, but the constitutional symptoms were not especially marked. These three cases were also seen six days later. At that time the crusts upon the body of the second child had entirely come off, and the pustules upon the body of the father had dried up and were in the crust stage of the disease. As in the case of the second child, one week previous, these crusts could be easily removed from the surface of the body, and left no induration or pitting of the skin. The patient was up and dressed, his temperature was normal, and to all appearances he was practically well.

On June 23, the date previously mentioned, I also saw another patient, named D., a young man twenty-two years of age, employed in one of the mills of the city. He had been taken ill two days previous, and, on account of the severe constitutional symptoms of the disease, had called a physician. At that time there was a marked headache, backache, high temperature, sore throat, and a beginning eruption upon the face and upper part of the body. At the time that I saw him the eruption had extended over the entire body. It was in the pustular stage upon the face and body, the extremities being more of the papular variety changing to vesicles. At one place on the body a vesicle was seen which was not umbilicated, and completely emptied its contents with one needle prick, showing

that it was not segmented. At the time no definite diagnosis could be made, but, on account of the possibility of the disease being variola, the board of health was advised to quarantine the house, and wait further developments of the disease. The patient was seen six days later, and at this time he was found to be up and dressed, and feeling much better than at the previous visit. The eruption had changed to the pustular stage all over the body, but in spite of this local condition he said that he felt perfectly well. He was also seen six days later still, and at this time the pustules had entirely disappeared, and nothing but crusts were present over his body. These could be easily removed with the finger nail, and under the crusts there was a slight tumefaction, resembling the warty form of variola. There was also considerable induration surrounding the seat of the eruption.

During this time the house was under constant quarantine, but with the recovery of the patient it was not deemed necessary to continue the isolation of the inmates of the house, and the quarantine was removed. With the strict isolation of these cases, however, similar ones developed in the same part of the city, which had not knowingly been exposed to these cases. Most of them were of so mild a character that no physician was ever called to see them, and on this account the board of health of the city determined to make a house-to-house canvass of this locality, vaccinate all persons not showing a recent scar, and isolate houses where cases were discovered. This investigation resulted in finding a large number of cases present, and much trouble was encountered by the board on account of the refusal of some of the families to be examined, and the hiding of patients ill with the disease.

On August 4 I made another visit to the city, and sixteen new cases of the same disease were seen, all having the same characteristics described above.

On August 14, as the condition was increasing rather than subsiding, it was deemed best, on account of the undoubted contagiousness of the disease, to open the small-pox hospital at Clark's Point, removing to it all patients then ill with the disease and those subsequently affected with it, and fumigate thoroughly the houses from which these patients were removed. With these additional precautions the disease was somewhat more controlled than it had been by allowing patients to remain at their own homes, but a few other cases did subsequently develop, and altogether, one hundred and seventy-one persons were taken ill. Of this number, sixty-three had been vaccinated, but most of them during infancy, so that the protection offered by vaccine virus had been considerably weakened; and two of the patients had been vaccinated after exposure to the disease, at a time too late for any beneficial effect. These patients were confined at the hospital until desquamation was entirely completed, and no new cases of the disease developed after the month of November. Two patients died, one a child, unvaccinated, who was thirteen months of age, and had a most extensive eruption over the whole body; and a male adult who after recovery from the disease insisted upon sleeping out of doors one night, and subsequently had pneumonia, which was fatal.

The peculiar character of the disease is its especially mild form, both at the onset and during the continuation of the eruption. In most of the patients there was either a slight chill or chilly sensation present, with a slight temperature, accompanied by a moderate amount of lumbar pain. It was so mild, in fact, that it was not necessary for them to go to bed, and in many cases not even necessary for them to call a physician. With the appearance of the eruption, which showed itself in two or three days, the above symptoms com-

pletely disappeared, and in the majority of the cases no other symptoms appeared except those due to the presence of the eruption on the body. The papular stage of the eruption was not especially different from that seen in the ordinary form of true small-pox, for it lasted two or three days and then gradually changed to the vesicular stage. This stage was in many cases only transitory in character, the vesicles being not well marked and generally not umbilicated. This stage only lasted about twenty-four hours, and rapidly changed into the pustular stage of the eruption. The pustules usually were of a large size, frequently as large as the tip of the little finger, conoidal in shape, distended with creamy white pus, with only a slight amount of infiltration about the pustule, and lasting only four or five days before the process of desiccation began. Even when this pustular eruption was very marked, there were few or no constitutional symptoms accompanying it. Desiccation was also rather more rapid in the course of this disease than is usually seen with true cases of small-pox; and in many cases a few days after the pustular eruption was at its height these crusts could be picked off by inserting the finger nail under the edge of the crusts, leaving either deeply pigmented areas, in which apparently the true skin was not involved, or a marked warty appearance of the skin, which usually disappeared without any disfigurement. Even when the cases were of the confluent variety, and many pustules existed over the whole body, the patient was not ill enough to require the services of a physician; and it was only by canvassing the localities in the city where the cases appeared that the local board of health was able to ascertain how many cases actually existed and to thoroughly quarantine them.

The fact that this large number of cases existed, a majority of them unvaccinated, and accompanied by so slight a mortality, would indicate that this was a most unusual form of small-pox. It was undoubtedly infectious, and communicable from one to another; and it was only by placing in force such strict isolation and quarantine as is customary with small-pox that the spread of the disease was prevented.

West Springfield.

The following reports of Medical Inspector Morse relate to outbreaks of diphtheria and of typhoid fever which occurred at West Springfield in 1900: —

During the six months preceding February 1, the reports of contagious diseases from West Springfield showed an unusual number of cases of diphtheria present and on February 6, after communicating by letter with the local board of health a visit was made to the town, to investigate the cause of the disease and advise the board to take measures to control its spread. During August, 1899, twenty-nine cases of diphtheria were reported; September, forty-four cases; October, thirty-seven cases; November, twenty-five cases; December, twenty-four cases; and during January, 1900, eighteen cases were reported, being a total of one hundred and seventy-seven, or in proportion to its population over ten times as many as the city of Boston had during the same time. Of this number, twenty only were among adults, the remainder being among school children, or those too young to attend school.

The town of West Springfield is composed of three villages: — Merrick, just across the river from Springfield; West Springfield proper, farther west; and

Mittineague, still farther west, and located on a hill overlooking the two other villages. The cases of diphtheria were not located in any one district, but were distributed over the whole territory, apparently bearing a close relationship to the density of the population, and no particular school seemed to be affected more than another.

Inquiry was made regarding isolation measures, and it was found that, although each and every case was strictly quarantined until apparent recovery had taken place, no cultures were taken from the throats of those affected, to determine the absence of the diphtheria bacilli, and that the fumigating was done with sulphur, although a formaldehyde apparatus was owned by the board, their excuse for not using it being that it was too heavy to transport from one house to another.

The board were advised of the necessity of availing themselves of the latest methods of preventing the spread of the disease by the use of culture tubes and formaldehyde, which advice was followed, with the result of having only two more cases appear during the remainder of the month of February and none during the early part of the month of March.

It was further learned, as a result of my visit, that on account of the dry season the public water supply had been insufficient to supply the needs of the inhabitants, and on January 27, from seven to ten P.M., water was pumped from the Westfield River by a pump in the paper mill to the stand-pipe at Mittineague, and subsequently distributed to the inhabitants. The water of this river is known to be extensively polluted above the point of the intake, and during the past two years this board has twice advised the water commissioners of the town not to use the river water, under any conditions. This advice was disregarded, and as a result of it the people of the town were unknowingly drinking polluted water One of the commissioners was interviewed, and he offered the excuse that it was necessary for fire purposes; but with the subsequent heavy rains it has not been necessary to resort to this supply again. Fortunately, no cases of sickness developed as a result of its use.

During the latter part of July a communication was received from the agent of the board of health of West Springfield, conveying the information that several cases of typhoid fever had appeared in a family in that village, and desiring an investigation made as to the origin of the disease. As a result of a visit made there on August 1, it was learned that five cases of typhoid fever had appeared in the family of Mr. A. The first patient to become ill with the disease was a girl fourteen years of age, who went to bed on May 5. She was in bed about four weeks, with a comparatively mild case of the disease. She was attended by her mother during the course of her illness, who attended the other members of the family until she herself was taken ill, some time afterward. The next cases to appear were two other children, four and seven years of age, who were taken ill on June 1 and 3 respectively. They were somewhat more ill than their sister, but both eventually recovered from the disease. On July 12, a third child, ten years of age, was taken ill with apparently a malignant form of the disease, for she died on July 19, seven days after going to bed. The mother, aged thirty-four years, was taken ill on July 15, and was still confined to her bed at the time of my visit.

The appearance of these five cases of the disease in a neighborhood where there was no history of other cases appearing was certainly a source of alarm to the

authorities. The house in which they live was built some five years ago, being originally constructed with a store in the front of it, without any cellar, the framework of the house being erected upon posts driven into the ground. The drinking water was obtained from a driven well some thirty feet deep, located underneath the house. The sanitary conditions were extremely deficient, the sink-drain water being conducted by a lead pipe through the side of the house to an open trough, thence into a wooden barrel which had been buried in the ground for the purpose of collecting the water. This barrel was located only fifteen feet from the well, and in such a position that its contents must have filtered directly into it. The privy was located about thirty feet from the house, a hen yard, in which there were thirty or forty hens, intervening between them. The milk supply was obtained from Mr. B., but there is no evidence that his milk was the source of infection, as no other cases appeared among other families supplied by him. A sample of water was taken from the well at the house, and found upon analysis to be considerably polluted.

With the existing conditions, it is probable that the original infection was received by drinking the polluted water of this well; and, with the appearance of the disease in the house, it was a comparatively easy matter for the disease to be contracted by the other members of the family, either from the original source or from direct infection from the patient herself.

The West Springfield board of health were advised in regard to improving the sanitary conditions of the house, and to prevent the further use of the water obtained from this polluted source.

Winchester.

We are thoroughly convinced that fumigation with formaldehyde is most effectual, and it is our plan to thoroughly disinfect all houses and school buildings in which contagious disease breaks out, and prevent all children from infected families or houses from attending school until all danger is past. The board of health has been greatly assisted by the co-operation of the physicians and the school department. In every instance there has been a quick and hearty response to all requests and suggestions made to superintendent and teachers, and much of our success in the restriction and prevention of the spread of contagious diseases may be attributed to the faithful enforcement of the school regulations.

Worcester.

Seven hundred and seventy-seven plans of plumbing were filed at the office during the year; 291 were for new buildings, 10 of which were stables; 486 were old buildings, 10 of which were stables.

There were filed during the year 86 applications for stable licenses. All of these were granted except 7, for 89 horses and 2 cows, which were given leave to withdraw.

Bacteriological Department.

The work of this department has been as satisfactory as in previous years; 2,845 cultures were examined in all.

Our recommendation of last year, for an underground station on the common, received the approval of the city council.

During the year the inspectors were present at the killing and inspection of 1,600 head of cattle, 372 calves, 105 hogs and 16 sheep. Twenty-five carcasses of beef, weighing 10,049 pounds, were condemned and sent to the rendering works.

The bath houses were opened for use June 9 and were closed September 22. Twenty-four thousand six hundred and sixty men and boys used the bath house during the season. The second full year of use of the women's bath house shows a gratifying increase over that of the year previous; there were 8,724 bathers this season, while last year there were 3,048.

Two thousand one hundred and fifty-three children were vaccinated this year.

We renew our recommendation that an appropriation be made for medical inspection in the schools.

The fourth year of the existence of the isolation hospital has passed, and in every respect the work continues to be most satisfactory. Three hundred and thirty-eight cases were treated during the year, a large increase over the year preceding. All of the admissions were voluntary. In other words, the board of health, although possessing ample authority, has not as yet forced any patient to enter against his will or that of his parents.

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